Gratitude

In appreciation and gratitude
to The Custodian of the Two Holy Mosques

King Abdullah Bin Abdul Aziz Al Saud

And

H.R.H. Prince Sultan Bin Abdul Aziz Al Saud

Crown Prince, Deputy Premier, Minister of Defence
& Aviation and Inspector General

For their continuous support and gracious consideration,
the Saudi Building Code National Committee (SBCNC)
is honored to present the first issue of
the Saudi Building Code (SBC).

Saudi Building Code Requirements

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PREFACE

The Saudi Building Code (SBC) is a set of legal, administrative and technical regulations and requirements that specify the minimum standards of construction for building in order to ensure public safety and health. A Royal Decree dated 11th June 2000 order the formation of a national committee composed of representatives of Saudi universities and governmental and private sectors. In September 2001, the Council of Ministers approved the general plan of the National Committee to develop a national building code for the Kingdom of Saudi Arabia.

To choose a base code for the Saudi Building Code, a number of Codes have been studied. The National Committee has been acquainted with the results of the national researches and the international codes from the U.S.A., Canada and Australia, also, the European Code, and Arab Codes. It has also sought the opinions of specialists in relevant Saudi universities, governmental and private sectors through holding a questionnaire, a symposium and specialized workshops, in the light of which, (ICC) has been chosen to be a base code for the Saudi Building Code.

The International Code Council (ICC) grants permission to the Saudi Building Code National Committee (SBCNC) to include all or any portion of material from the ICC codes, and standards in the SBC and ICC is not responsible or liable in any way to SBCNC or to any other party or entity for any modifications or changes that SBCNC makes to such documents.

Toward expanding the participation of all the specialists in the building and construction industry in the Kingdom through the governmental and private sectors, the universities and research centers, the National Committee took its own decisions related to code content by holding specialized meetings, symposiums and workshops and by the help of experts from inside and outside of Saudi Arabia.

The technical committees and sub-committees started their work in April 2003 to develop the Saudi Building Code that adapts the base code with the social and cultural environment, the natural and climatic conditions, types of soil and properties of materials in the Kingdom.

The Saudi Building Code Mechanical Requirements (SBC 501) were developed based on the International Mechanical Code (IMC) and on a number of ASME Standards pursuant to a license with ASME.

The development process of SBC 501 followed the methodology that was approved by the Saudi Building Code National Committee, taking into considerations the materials, environmental conditions, and construction practices prevailing in the Kingdom.

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CHAPTER 1
GENERAL REGULATIONS

SECTION 1.1
GENERAL

1.1.1 **Scope.** This chapter shall govern the approval and installation of all equipment and appliances that comprise parts of the building mechanical systems regulated by these Requirements in accordance with Section 1.1.2.

1.1.2 **Energy utilization**. Heating, ventilating and air-conditioning systems of all structures shall be designed and installed for efficient utilization of energy in accordance with the Saudi Building Code Energy Conservation Requirements.

1.1.3 **Fuel gas appliances and equipment.** The approval and installation of fuel gas distribution piping and equipment, fuel gas-fired appliances and fuel gas-fired appliance venting systems shall be in accordance with the Saudi Building Code Fuel Gas Requirements.

1.1.4 **Listed and labeled.** All appliances regulated by these Requirements shall be listed and labeled, unless otherwise approved by Code official.

1.1.5 **Labeling.** Labeling shall be in accordance with the procedures set forth in Sections 1.1.5.1 through 1.1.5.2.3.

1.1.5.1 **Testing.** An approved agency shall test a representative sample of the mechanical equipment and appliances being labeled to the relevant standard or standards. The approved agency shall maintain a record of all of the tests performed. The record shall provide sufficient detail to verify compliance with the test standard.

1.1.5.2 **Inspection and identification.** The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the mechanical equipment and appliances to be labeled. The inspection shall verify that the labeled mechanical equipment and appliances are representative of the mechanical equipment and appliances tested.

1.1.5.2.1 **Independent.** The agency to be approved shall be objective and competent. To confirm its objectivity, the agency shall disclose all possible conflicts of interest.

1.1.5.2.2 **Equipment.** An approved agency shall have adequate equipment to perform all required tests. The equipment shall be periodically calibrated.

1.1.5.2.3 **Personnel.** An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests.

1.1.6 **Label information.** A permanent factory applied name plate(s) shall be affixed to appliances on which shall appear in legible lettering, the manufacturer's name or trademark, the model number, serial number and the seal or mark of the approved agency. A label shall also include the following:

1. Electrical equipment and appliances: Electrical rating in volts, amperes and motor phase; identification of individual electrical components in volts, amperes or watts, motor phase; W output; and required clearances.
2. Absorption units: Hourly rating in W; minimum hourly rating for units having step or automatic modulating controls; type of fuel; type of refrigerant; cooling capacity in W; and required clearances.
3. Fuel-burning units: Hourly rating in W; type of fuel approved for use with the appliance; and required clearances.

4. Electric comfort heating appliances: Name and trademark of the manufacturer; the model number or equivalent; the electric rating in volts, ampacity and phase; W output rating; individual marking for each electrical component in amperes or watts, volts and phase; required clearances from combustibles; and a seal indicating approval of the appliance by an approved agency.

1.1.7 **Electrical.** Electrical wiring, controls and connections to equipment and appliances regulated by these Requirements shall be in accordance with the Saudi Electrical Requirements.

1.1.8 **Plumbing connections.** Potable water supply and building drainage system connections to equipment and appliances regulated by these Requirements shall be in accordance with the Saudi Plumbing Requirements.

1.1.9 **Fuel types.** Fuel-fired appliances shall be designed for use with the type of fuel to which they will be connected and the altitude at which they are installed. Appliances that comprise parts of the building mechanical system shall not be converted for the usage of a different fuel, except where approved and converted in accordance with the manufacturer's instructions. The fuel input rate shall not be increased or decreased beyond the limit rating for the altitude at which the appliance is installed.

1.1.10 **Vibration isolation.** Where vibration isolation of equipment and appliances is employed, an approved means of supplemental restraint shall be used to accomplish the support and restraint.

1.1.11 **Repair.** Defective material or parts shall be replaced or repaired in such a manner so as to preserve the original approval or listing.

1.1.12 **Wind resistance.** Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with the Saudi Building Code.

1.1.13 **Flood hazard.** For structures located in flood hazard areas, mechanical systems, equipment and appliances shall be located at or above the design flood elevation.

Exception: Mechanical systems, equipment and appliances are permitted to be located below the design flood elevation provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation in compliance with the flood-resistant construction Requirements of the Saudi Building Code.

1.1.13.1 **High-velocity wave action.** In flood hazard areas subject to high-velocity wave action, mechanical systems and equipment shall not be mounted on or penetrate walls intended to break away under flood loads.

1.1.14 **Rodent proofing.** Buildings or structures and the walls enclosing habitable or occupiable rooms and spaces in which persons live, sleep or work, or in which feed, food or foodstuffs are stored, prepared, processed, served or sold, shall be constructed to protect against the entrance of rodents in accordance with the Saudi Building Code.

1.1.15 **Seismic resistance.** When earthquake loads are applicable in accordance with the Saudi Building Code, mechanical system supports shall be designed and installed for the seismic forces in accordance with the Saudi Building Code.

SECTION 1.2
PROTECTION OF STRUCTURE

1.2.1 **Structural safety.** The building or structure shall not be weakened by the installation of mechanical systems. Where floors, walls, ceilings or any other portion of the building or structure are required to be altered or replaced in the process of installing or repairing any system, the building or structure shall be left in a safe structural condition in accordance with the Saudi Building Code.

1.2.2 **Penetrations of floor/ceiling assemblies and fire-resistance-rated assemblies.** Penetrations of floor/ceiling assemblies and assemblies required to have a fire-resistance rating shall be protected in accordance with the Saudi Building Code.

1.2.3 **Cutting, notching and boring in wood framing.** The cutting, notching and boring of wood framing members shall comply with Sections 1.2.3.1 through 1.2.3.4.

1.2.3.1 **Joist notching.** Notches on the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 50 mm of the top or bottom of the joist, and the diameter of any such hole shall not exceed one-third the depth of the joist. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.

1.2.3.2 **Stud cutting and notching.** In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched not to exceed 25 percent of its depth. Cutting or notching of studs not greater than 40 percent of their depth is permitted in nonbearing partitions supporting no loads other than the weight of the partition.

1.2.3.3 **Bored holes.** A hole not greater in diameter than 40 percent of the stud depth is permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the depth of the stud are permitted in nonbearing partitions or in any wall where each bored stud is doubled, provided not more than two such successive doubled studs are so bored. In no case shall the edge of the bored hole be nearer than 16 mm to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

1.2.3.4 **Engineered wood products.** Cuts, notches and holes bored in trusses, laminated veneer lumber, glue-laminated members and I-joists are prohibited except where the effects of such alterations are specifically considered in the design of the member.

1.2.4 **Alterations to trusses.** Truss members and components shall not be cut, drilled, notched, spliced or otherwise altered in any way without written concurrence and approval of a registered design professional. Alterations resulting in the addition of loads to any member (e.g., HVAC equipment, water heaters) shall not be permitted without verification that the truss is capable of supporting such additional loading.

1.2.5 **Cutting, notching and boring in steel framing.** The cutting, notching and boring of steel framing members shall comply with Sections 1.2.5.1 through 1.2.5.3.

1.2.5.1 **Cutting, notching and boring holes in structural steel framing.** The cutting, notching and boring of holes in structural steel framing members shall be as prescribed by the registered design professional.

1.2.5.2 **Cutting, notching and boring holes in cold-formed steel framing.** Flanges and lips of load-bearing cold-formed steel framing members shall not be cut or notched. Holes in webs of load-bearing cold-formed steel framing members shall be permitted

along the centerline of the web of the framing member and shall not exceed the dimensional limitations, penetration spacing or minimum hole edge distance as prescribed by the registered design professional. Cutting, notching and boring holes of steel floor/roof decking shall be as prescribed by the registered design professional.

1.2.5.3 **Cutting, notching and boring holes in non-structural cold-formed steel wall framing.** Flanges and lips of nonstructural cold-formed steel wall studs shall not be cut or notched. Holes in webs of nonstructural cold-formed steel wall studs shall be permitted along the centerline of the web of the framing member, shall not exceed 38 mm in width or 100 mm in length, and shall not be spaced less than 600 mm center to center from another hole or less than 250 mm from the bearing end.

SECTION 1.3
EQUIPMENT AND APPLIANCE LOCATION

1.3.1 **General.** Equipment and appliances shall be located as required by this section, specific Requirements elsewhere in these Requirements and the conditions of the equipment and appliance listing.

1.3.2 **Hazardous locations.** Appliances shall not be located in a hazardous location unless listed and approved for the specific installation.

1.3.3 **Prohibited locations.** Fuel-fired appliances shall not be located in, or obtain combustion air from, any of the following rooms or spaces:

1. Sleeping rooms.
2. Bathrooms.
3. Toilet rooms.
4. Storage closets.
5. Surgical rooms.

1.3.4 **Protection from damage.** Appliances shall not be installed in a location where subject to mechanical damage unless protected by approved barriers.

1.3.5 **Indoor locations.** Fuel-fired furnaces and boilers installed in closets and alcoves shall be listed for such installation. For purposes of this section, a closet or alcove shall be defined as a room or space having a volume less than 12 times the total volume of fuel-fired appliances other than boilers and less than 16 times the total volume of boilers. Room volume shall be computed using the gross floor area and the actual ceiling height up to a maximum computation height of 2.4 m.

1.3.6 **Outdoor locations.** Appliances installed in other than indoor locations shall be listed and labeled for outdoor installation.

1.3.7 **Pit locations.** Appliances installed in pits or excavations shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back a minimum of 300 mm from the appliance. Where the depth exceeds 300 mm below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry. Such concrete or masonry shall extend a minimum of 100 mm above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse. The appliance shall be protected from flooding in an approved manner.

1.3.8 **Elevator shafts.** Mechanical systems shall not be located in an elevator shaft.

SECTION 1.4
INSTALLATION

1.4.1 **General.** Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of the listing, the manufacturer's installation instructions and these Requirements. Manufacturer's installation instructions shall be available on the job site at the time of inspection.

1.4.2 **Conflicts.** Where conflicts between these Requirements and the conditions of listing or the manufacturer’s installation instructions occur, the provisions of these Requirements shall apply.

Exception: Where a code provision is less restrictive than the conditions of the listing of the equipment or appliance or the manufacturer's installation instructions, the conditions of the listing and the manufacturer's installation instructions shall apply.

1.4.3 **Elevation of ignition source.** Equipment and appliances having an ignition source and located in hazardous locations and public garages, private garages, repair garages, automotive motor-fuel-dispensing facilities and parking garages shall be elevated such that the source of ignition is not less than 460 mm above the floor surface on which the equipment or appliance rests. Such equipment and appliances shall not be installed in Group H occupancies or control areas where open use, handling or dispensing of combustible, flammable or explosive materials occurs. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

1.4.4 **Hydrogen generating and refueling operations.** Ventilation shall be required in accordance with Section 1.4.4.1, 1.4.4.2 or 1.4.4.3 in public garages, private garages, repair garages, automotive motor-fuel-dispensing facilities and parking garages which contain hydrogen generating appliances or refueling systems. Such spaces shall be used for the storage of not more than three hydrogen-fueled passenger motor vehicles and have a floor area not exceeding 80 square meter. The maximum rated output capacity of hydrogen generating appliances shall not exceed 1.8 liter/sec. of hydrogen for each 23 square meters of floor area in such spaces. Such equipment and appliances shall not be installed in Group H occupancies except where the occupancy is specifically designed for hydrogen use, or in control areas where open-use, handling or dispensing of combustible, flammable or explosive materials occurs. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

1.4.4.1 **Natural ventilation.** Indoor locations intended for hydrogen generating or refueling operations shall communicate with the outdoors in accordance with Sections 1.4.4.1.1 and 1.4.4.1.2. The minimum dimension of air openings shall be not less than 75mm. Where ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. In such locations, equipment and appliances having an ignition source shall be located such that the source of ignition is not less than 300 mm below the ceiling.

1.4.4.1.1 **Two openings.** Two permanent openings, one located entirely within 300 mm of the ceiling of the garage, and one located entirely within 300 mm of the floor of the garage, shall be provided in the same exterior wall. The openings shall communicate directly, or by ducts, with the outdoors. Each opening shall directly communicate

with the outdoors horizontally, and have a minimum free area of 1640 mm^2/m^3 of garage volume.

1.4.4.1.2 **Louvers and grilles.** In calculating free area required by Section 1.4.4.1, the required size of openings shall be based on the net free area of each opening. If the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. If the design and free area are not known, it shall be assumed that wood louvers will have 25 percent free area and metal louvers and grilles will have 75 percent free area. Louvers and grilles shall be fixed in the open position.

1.4.4.2 **Mechanical ventilation.** Indoor locations intended for hydrogen generating or refueling operations shall be ventilated in accordance with Section 3.2.16.

1.4.4.3 **Specially engineered installations.** As an alternative to the provisions of Sections 1.4.4.1 and 1.4.4.2 the necessary supply of air for ventilation and dilution of flammable gases shall be provided by an approved engineered system.

1.4.5 **Public garages.** Appliances located in public garages, service stations, repair garages or other areas frequented by motor vehicles, shall be installed a minimum of 2.4 m above the floor. Where motor vehicles exceed 1830 mm in height and are capable of passing under an appliance, appliances shall be installed a minimum of 600 mm higher above the floor than the height of the tallest vehicle.

Exception: The Requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 1.4.3 and (NFPA 88B).

1.4.6 **Private garages.** Appliances located in private garages and carports shall be installed with a minimum clearance of 1.8 m above the floor.

Exception: The Requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 1.4.3.

1.4.7 **Construction and protection.** Boiler rooms and furnace rooms shall be protected as required by the Saudi Building Code.

1.4.8 **Clearances to combustible construction.** Heat producing equipment and appliances shall be installed to maintain the required clearances to combustible construction as specified in the listing and manufacturer's instructions. Such clearances shall be reduced only in accordance with Section 1.8. Clearances to combustibles shall include such considerations as door swing, drawer pull, overhead projections or shelving and window swing, shutters, coverings and drapes. Devices such as doorstops or limits, closers, drapery ties or guards shall not be used to provide the required clearances.

1.4.9 **Clearances from grade.** Equipment and appliances installed at grade level shall be supported on a level concrete slab or other approved material extending above adjoining grade or shall be suspended a minimum of 150 mm above adjoining grade.

1.4.10 **Guards.** Guards shall be provided where appliances, equipment, fans or other components that require service are located within 3.0 m of a roof edge or open side of a walking surface and such edge or open side is located more than 750 mm above the floor, roof or grade below. The guard shall extend not less than 750 mm beyond each end of such appliance, equipment, fan or component and the top of the guard shall be located not less than 1.0 m above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 500 mm-diameter

sphere and shall comply with the loading Requirements for guards specified in the Saudi Building Code.

1.4.11 **Area served.** Appliances serving different areas of a building other than where they are installed shall be permanently marked in an approved manner that uniquely identifies the appliance and the area it serves.

SECTION 1.5
PIPING SUPPORT

1.5.1 **General.** All mechanical system piping shall be supported in accordance with this section.

1.5.2 **Materials.** Pipe hangers and supports shall have sufficient strength to withstand all anticipated static and specified dynamic loading conditions associated with the intended use. Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

1.5.3 **Structural attachment.** Hangers and anchors shall be attached to the building construction in an approved manner.

1.5.4 **Interval of support.** Piping shall be supported at distances not exceeding the spacing specified in Table 1.5.4.

Table 1.5.4
Piping Support Spacing

Piping Material	Maximum Horizontal Spacing (mm)	Maximum Vertical Spacing (mm)
ABS pipe	1200	3000 [c]
Aluminum pipe and tubing	3000	4500
Brass pipe	3000	3000
Brass tubing, 32 mm diameter and smaller	1800	3000
Brass tubing, 38 mm diameter and larger	3000	3000
Cast-iron pipe[b]	1500	4500
Copper or copper-alloy pipe	3600	3000
Copper or copper-alloy tubing, 32 mm diameter and	1800	3000
Copper or copper-alloy tubing, 38 mm diameter and	3000	3000
CPVC pipe or tubing, 25.4 mm and smaller	900	4000
CPVC pipe or tubing, 32 mm and larger	1200	3000[c]
Steel pipe	3600	4500
Steel tubing	2400	3000
Lead pipe	Continuous	1200
PB pipe or tubing	800	1200
PEX tubing	800	3000[c]
PVC pipe	1200	3000[c]

a. See Section 1.1.14.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 3 meter where 3-meter lengths of pipe are installed.
c. Mid-story guide.

1.5.5 **Protection against physical damage.** In concealed locations where piping, other than cast-iron or steel, is installed through holes or notches in studs, joists, rafters or similar members less than 38 mm from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1.5 mm-thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 50 mm above sole plates and below top plates.

SECTION 1.6
ACCESS AND SERVICE SPACE

1.6.1 **Clearances for maintenance and replacement.** Clearances around appliances to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly.

1.6.1.1 **Central furnaces.** Central furnaces within compartments or alcoves shall have a minimum working space clearance of 76 mm along the sides, back and top with a total width of the enclosing space being at least 300 mm wider than the furnace. Furnaces having a firebox open to the atmosphere shall have at least 150 mm working space along the front combustion chamber side. Combustion air openings at the rear or side of the compartment shall comply with the Requirements of Chapter 5.

Exception: This section shall not apply to replacement appliances installed in existing compartments and alcoves where the working space clearances are in accordance with the equipment or appliance manufacturer's installation instructions.

1.6.2 **Appliances in rooms.** Rooms containing appliances requiring access shall be provided with a door and an unobstructed passageway measuring not less than 900 mm wide and 2.0 meter high.

Exception: Within a dwelling unit, appliances installed in a compartment, alcove, basement or similar space shall be accessed by an opening or door and an unobstructed passageway measuring not less than 600 mm wide and large enough to allow removal of the largest appliance in the space, provided that a level service space of not less than 750 mm deep and the height of the appliance, but not less than 750 mm, is present at the front or service side of the appliance with the door open.

1.6.3 **Appliances in attics.** Attics containing appliances requiring access shall be provided with an opening and unobstructed passageway large enough to allow removal of the largest appliance. The passageway shall not be less than 750 mm high and 550 mm wide and not more than 6.0 m in length measured along the centerline of the passageway from the opening to the appliance. The passageway shall have continuous solid flooring not less than 600 mm wide. A level service space not less than 750 mm deep and 750 mm wide shall be present at the front or service side of the appliance. The clear access opening dimensions shall be a minimum of 500 mm by 750 mm, where such dimensions are large enough to allow removal of the largest appliance.

Exception: The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.

1.6.3.1 **Electrical Requirements.** A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the appliance location in accordance with the Saudi Electrical Requirements.

1.6.4 **Equipment and appliances on roofs or elevated structures.** Where equipment and appliances requiring access are installed on roofs or elevated structures at a height

exceeding 4.8 m, such access shall be provided by a permanent approved means of access, the extent of which shall be from grade or floor level to the equipment and appliances. Level service space. Such access shall not require climbing over obstructions greater than 750 mm high or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33 percent slope).

Permanent ladders installed to provide the required access shall comply with the following minimum design criteria:

1. The side railing shall extend above the parapet or roof edge not less than 750 mm.
2. Ladders shall have rung spacing not to exceed 350 mm on center.
3. Ladders shall have a toe spacing not less than 150 mm deep.
4. There shall be a minimum of 450 mm between rails.
5. Rungs shall have a minimum 20 mm diameter and be capable of withstanding a 136 kg load.
6. Ladders over 9.0 m in height shall be provided with offset sections and landings capable of withstanding 480 kg/m^2.
7. Ladders shall be protected against corrosion by approved means.

Catwalks installed to provide the required access shall be not less than 600 mm wide and shall have railings as required for service platforms.

Exception: This section shall not apply to Group R-3 occupancies.

1.6.5 **Sloped roofs.** Where appliances are installed on a roof having a slope of 3 units vertical in 12 units horizontal (25-percent slope) or greater and having an edge more than 750 mm above grade at such edge, a level platform shall be provided on each side of the appliance to which access is required by the manufacturer's installation instructions for service, repair or maintenance. The platform shall not be less than 750 mm in any dimension and shall be provided with guards in accordance with Section 1.4.10.

SECTION 1.7
CONDENSATE DISPOSAL

1.7.1 **Fuel-burning appliances.** Liquid combustion by-products of condensing appliances shall be collected and discharged to an approved plumbing fixture or disposal area in accordance with the manufacturer's installation instructions. Condensate piping shall be of approved corrosion-resistant material and shall not be smaller than the drain connection on the appliance. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

1.7.2 **Evaporators and cooling coils.** Condensate drain systems shall be provided for equipment and appliances containing evaporators or cooling coils. Condensate drain systems shall be designed, constructed and installed in accordance with Sections 1.7.2.1 through 1.7.2.4.

1.7.2.1 **Condensate disposal.** Condensate from all cooling coils and evaporators shall be conveyed from the drain pan outlet to an approved place of disposal. Condensate shall not discharge into a street, alley or other areas so as to cause a nuisance.

1.7.2.2 **Drain pipe materials and sizes.** Components of the condensate disposal system shall be cast iron, galvanized steel, copper, cross-linked polyethylene, polybutylene, polyethylene, ABS, CPVC or PVC pipe or tubing. All components shall be selected for the pressure and temperature rating of the installation. Condensate waste and drain line size shall be not less than 20 mm internal diameter and shall not decrease in size from the drain pan connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage,

the pipe or tubing shall be sized in accordance with an approved method. All horizontal sections of drain piping shall be installed in uniform alignment at a uniform slope.

1.7.2.3 **Auxiliary and secondary drain systems.** In addition to the Requirements of Section 1.7.2.1, a secondary drain or auxiliary drain pan shall be required for each cooling or evaporator coil where damage to any building components will occur as a result of overflow from the equipment drain pan or stoppage in the condensate drain piping. One of the following methods shall be used:

1. An auxiliary drain pan with a separate drain shall be provided under the coils on which condensation will occur. The auxiliary pan drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The pan shall have a minimum depth of 38 mm, shall not be less than 75 mm larger than the unit or the coil dimensions in width and length and shall be constructed of corrosion resistant material. Metallic pans shall have a minimum thickness of not less than 0.7 mm galvanized sheet metal. Nonmetallic pans shall have a minimum thickness of not less than 1.6 mm.
2. A separate overflow drain line shall be connected to the drain pan provided with the equipment. Such overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.
3. An auxiliary drain pan without a separate drain line shall be provided under the coils on which condensate will occur. Such pan shall be equipped with a water level detection device that will shut off the equipment served prior to overflow of the pan. The auxiliary drain pan shall be constructed in accordance with item 1 of this section.

1.7.2.4 **Traps.** Condensate drains shall be trapped as required by the equipment or appliance manufacturer.

SECTION 1.8
CLEARANCE REDUCTION

1.8.1 **Scope.** This section shall govern the reduction in required clearances to combustible materials and combustible assemblies for chimneys, vents, kitchen exhaust equipment, mechanical appliances, and mechanical devices and equipment.

1.8.2 **Listed appliances and equipment.** The reduction of the required clearances to combustibles for listed and labeled appliances and equipment shall be in accordance with the Requirements of this section except that such clearances shall not be reduced where reduction is specifically prohibited by the terms of the appliance or equipment listing.

1.8.3 **Protective assembly construction and installation.** Reduced clearance protective assemblies, including structural and support elements, shall be constructed of noncombustible materials. Spacers utilized to maintain airspace between the protective assembly and the protected material or assembly shall be noncombustible. Where a space between the protective assembly and protected combustible material or assembly is specified, the same space shall be provided around the edges of the protective assembly and the spacers shall be placed so as to allow air circulation by convection in such space. Protective assemblies shall not be placed less than 25 mm from the mechanical appliances, devices or equipment, regardless of the allowable reduced clearance.

1.8.4 Allowable reduction. The reduction of required clearances to combustible assemblies or combustible materials shall be based on the utilization of a reduced clearance protective assembly in accordance with Section 1.8.5 or 1.8.6.

1.8.5 Labeled assemblies. The allowable clearance reduction shall be based on an approved reduced clearance protective assembly that has been tested and bears the label of an approved agency.

1.8.6 Reduction table. The allowable clearance reduction shall be based on one of the methods specified in Table 1.8.6. Where required clearances are not listed in Table 1.8.6, the reduced clearances shall be determined by linear interpolation between the distances listed in the table. Reduced clearances shall not be derived by extrapolation below the range of the table.

Table 1.8.6
Clearance Reduction Methods

Type of Protective Assembly[a]	Reduced Clearance with Protection (mm)[a]							
	Horizontal combustible assemblies located above the heat source				Horizontal combustible assemblies located beneath the heat source and all vertical combustible assemblies			
	Required clearance to combustibles without protection (mm)[2]				Required clearance to combustible without protection (mm)[2]			
	900	450	230	150	900	450	230	150
Galvanized sheet metal, minimum nominal thickness of 0.6 mm (No. 24 Gage), mounted on 25 mm glass fiber or mineral wool batt reinforced with wire on the back, 25 mm off the combustible assembly	450	230	125	75	300	150	75	75
Galvanized sheet metal, minimum nominal thickness of 0.6 mm (No. 24 Gage), spaced 25 mm off the combustible assembly	450	230	125	75	300	150	75	75
Two layers of galvanized sheet metal, minimum nominal thickness of 0.6 mm (No. 24 Gage), having a 25 mm airspace between layers, spaced 25 mm off the combustible assembly	450	230	125	75	300	150	75	75
Two layers of galvanized sheet metal, minimum nominal thickness of 0.6 mm (No. 24 Gage), having 25 mm of fiberglass insulation between layers, spaced 25 mm off the combustible assembly	450	230	125	75	300	150	75	75
12.5 mm inorganic insulating board, over 25 mm of fiberglass or mineral wool batt, against the combustible assembly	600	300	150	100	450	230	125	75
90 mm brick wall, spaced 25 mm off the combustible wall	----	----	----	----	300	150	150	150
90 mm brick wall, against the combustible wall	----	----	----	----	600	300	150	125

a. Mineral wool and glass fiber batts (blanket or board) shall have a minimum density of 128.0 Kg/m^3 and a minimum melting point of 815°C. Insulation material utilized as part of a clearance reduction system shall have a thermal conductivity of 0.144 $W/m^2 \cdot K$ or less. Insulation board shall be formed of noncombustible material.

1.8.7 **Solid fuel-burning appliances.** The clearance reduction methods specified in Table 1.8.6 shall not be utilized to reduce the clearance required for solid fuel-burning appliances that are labeled for installation with clearances of 300 mm or less. Where appliances are labeled for installation with clearances of greater than 300 mm, the clearance reduction methods of Table 1.8.6 shall not reduce the clearance to less than 300 mm.

1.8.8 **Masonry chimneys.** The clearance reduction methods specified in Table 1.8.6 shall not be utilized to reduce the clearances required for masonry chimneys as specified in Chapter 6 and the Saudi building code.

1.8.9 **Chimney connector pass-through.** The clearance reduction methods specified in Table 1.8.6 shall not be utilized to reduce the clearances required for chimney connector pass-through as specified in Section 6.3.10.4.

1.8.10 **Masonry fireplaces.** The clearance reduction methods specified in Table 1.8.6 shall not be utilized to reduce the clearances required for masonry fireplaces as specified in Chapter 6 and the Saudi building code.

1.8.11 **Kitchen exhaust ducts.** The clearance reduction methods specified in Table 1.8.6 shall not be utilized to reduce the minimum clearances required by Section 3.6.3.10 for kitchen exhaust ducts enclosed in a shaft.

SECTION 1.9
TEMPERATURE CONTROL

1.9.1 **Space-heating systems.** Interior spaces intended for human occupancy shall be provided with active or passive space-heating systems capable of maintaining a minimum indoor temperature of 20°C at a point 915 mm above floor on the design heating day. The installation of portable space heaters shall not be used to achieve compliance with this section.

Exception: Interior spaces where the primary purpose is not associated with human comfort.

SECTION 1.10
EXPLOSION CONTROL

1.10.1 **Required.** Structures occupied for purposes involving explosion hazards shall be provided with explosion control where required by the Saudi Fire Requirements. Explosion control systems shall be designed and installed in accordance with the Saudi Building Code Fire Protection Requirements.

SECTION 1.11
SMOKE AND HEAT VENTS

1.11.1 **Smoke and Heating Vents.** Approved smoke and heat vents shall be installed in the roofs of one-story buildings where required by the Saudi Fire Requirements. Smoke and heat vents shall be designed and installed in accordance with the Saudi Building Code Fire Protection Requirements.

SECTION 1.12
HEATING AND COOLING LOAD CALCULATIONS

1.12.1 **Load calculations.** Heating and cooling system design loads for the purpose of sizing systems, appliances and equipment shall be determined in accordance with the procedures described in the ASHRAE Handbook of Fundamentals. Heating and cooling loads shall be adjusted to account for load Reductions that are achieved when energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE Handbook – HVAC Systems and Equipment. Alternatively, design loads shall be determined by an approved equivalent computation procedure, using the design parameters specified in the Saudi Energy Conservation Requirements.

CHAPTER 2
VENTILATION

SECTION 201
GENERAL

2.1.1 **Scope.** This chapter shall govern the ventilation of spaces within a building intended to be occupied.

2.1.2 **Ventilation required.** Every occupied space shall be ventilated by natural means in accordance with Section 2.2 or by mechanical means in accordance with Section 2.3.

2.1.3 **When required.** Ventilation shall be provided during the periods that the room or space is occupied.

2.1.4 **Exits.** Equipment and ductwork for exit enclosure ventilation shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the exit enclosure by ductwork enclosed in construction as required by the *Saudi Building Code Basic Regulations* for shafts.
2. Where such equipment and ductwork is located within the exit enclosure, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required by the *Saudi Building Code Basic Regulations* for shafts.
3. Where located within the building, such equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required by the *Saudi Building Code Basic Regulations* for shafts. In each case, openings into fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire resistance-rated devices in accordance with the *Saudi Building Code Basic Regulations* for enclosure wall opening protective.
4. Exit enclosure ventilation systems shall be independent of other building ventilation systems.

2.1.5 **Opening location.** Outside air exhaust and intake openings shall be located a minimum of 3 meter from lot lines or buildings on the same lot. Where openings front on a street or public way, the distance shall be measured to the centerline of the street or public way.

2.1.5.1 **Intake openings.** Mechanical and gravity outside air intake openings, shall be located a minimum of 3 meter from any hazardous contaminant such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks, except as otherwise specified in these requirements. Where a source of contaminant is located within 3 meter of an intake opening, such opening shall be located a minimum of 0.6 meter below the contaminant source.

2.1.5.2 **Exhaust openings.** Outside exhaust openings shall be located so as not to create a nuisance. Exhaust air shall not be directed onto walkways.

2.1.5.3 **Flood hazard.** For structures located in flood hazard areas, outdoor exhaust openings shall be at or above the design flood elevation.

2.1.6 **Outdoor opening protection.** Air exhaust and intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles.

Openings in louvers, grilles and screens shall be sized in accordance with Table 2.1.6, and shall be protected against local weather conditions. Outdoor air exhaust and intake openings located in exterior walls shall meet the provisions for exterior wall opening protective in accordance with the *Saudi Building Code Basic Regulations*.

Table 2.1.6
Opening Sizes in Louvers, Grilles and Screens Protecting Outdoor Exhaust and Air Intake Openings

Outdoor Opening Type	Minimum and Maximum Opening Sizes in Louvers, Grilles and Screens Measured in any Direction
Exhaust openings	Not < 6.5 mm and not >12.5 mm
Intake openings in residential occupancies	Not < 6.5 mm and not >12.5 mm
Intake openings in other than residential occupancies	>6.5 mm and not >25.5 mm

2.1.7 **Contaminant sources.** Stationary local sources producing air-borne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantities as to be irritating or injurious to health shall be provided with an exhaust system in accordance with Chapter 3 or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an approved location at the exterior of the building.

2.1.8 **Granite flooring.** Building using granite as internal flooring should have extra ventilation above minimum required outdoor ventilation rate as per Table 2.3.3 in Section 2.3 according to the international safety recommendations for the minimum exposure limits for Radon gas radiation.

SECTION 2.2
NATURAL VENTILATION

2.2.1 **Natural ventilation.** Natural ventilation of an occupied space shall be through windows, doors, louvers or other openings to the outdoors. The operating mechanism for such openings shall be provided with ready access so that the openings are readily controllable by the building occupants.

2.2.2 **Ventilation area required.** The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.

2.2.3 **Adjoining spaces.** Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the opening to the adjoining rooms shall be unobstructed and shall have an area not less than 8 percent of the floor area of the interior room or space, but not less than 2.3 square meters. The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

2.2.4 **Openings below grade.** Where openings below grade provide required natural ventilation, the outside horizontal clear space measured perpendicular to the opening shall be one and one-half times the depth of the opening. The depth of the opening shall be measured from the average adjoining ground level to the bottom of the opening.

SECTION 2.3
MECHANICAL VENTILATION

2.3.1 **Ventilation system.** Mechanical ventilation shall be provided by a method of supply air and return or exhaust air. The amount of supply air shall be approximately equal to the amount of return and exhaust air. The system shall not be prohibited from producing negative or positive pressure. The system to convey ventilation air shall be designed and installed in accordance with Chapter 4.

Ventilation supply systems shall be designed to deliver the required rate of supply air to the occupied zone within an occupied space. The occupied zone shall have boundaries measured at 75 mm. and 1.8 m above the floor and 600 mm from the enclosing walls.

2.3.2 **Outdoor air required.** The minimum ventilation rate of required outdoor air shall be determined in accordance with Section 2.3.3.

2.3.2.1 **Recirculation of air.** The air required by Section 2.3.3 shall not be recirculated. Air in excess of that required by Section 2.3.3 shall not be prohibited from being recirculated as a component of supply air to building spaces, except that:

1. Ventilation air shall not be recirculated from one dwelling unit to another or to dissimilar occupancies.
2. Supply air to a swimming pool and associated deck areas shall not be recirculated unless such air is dehumidified to maintain the relative humidity of the area at 60 percent or less. Air from this area shall not be recirculated to other spaces.
3. Where mechanical exhaust is required by Table 2.3.3, recirculation of air from such spaces shall be prohibited. All air supplied to such spaces shall be exhausted, including any air in excess of that required by Table 2.3.3.

2.3.2.2 **Transfer air.** Except where recirculation from such spaces is prohibited by Table 2.3.3, air transferred from occupied spaces is not prohibited from serving as makeup air for required exhaust systems in such spaces as kitchens, baths, toilet rooms, elevators and smoking lounges. The amount of transfer air and exhaust air shall be sufficient to provide the flow rates as specified in Sections 2.3.3 and 2.3.3.1. The required outdoor air rates specified in Table 2.3.3 shall be introduced directly into such spaces or into the occupied spaces from which air is transferred or a combination of both.

2.3.3 **Ventilation rate.** Ventilation systems shall be designed to have the capacity to supply the minimum outdoor airflow rate determined in accordance with Table 2.3.3 based on the occupancy of the space and the occupant load or other parameter as stated therein. The occupant load utilized for design of the ventilation system shall not be less than the number determined from the estimated maximum occupant load rate indicated in Table 2.3.3. Ventilation rates for occupancies not represented in Table 2.3.3 shall be determined by an approved engineering analysis. The ventilation system shall be designed to supply the required rate of ventilation air continuously during the period the building is occupied, except as otherwise stated in other provisions of the code.

2.3.3.1 **System operation.** The minimum flow rate of outdoor air that the ventilation system must be capable of supplying during its operation shall be based on the rate per person indicated in Table 2.3.3 and the actual number of occupants present.

2.3.3.2 **Common ventilation system.** Where spaces having different ventilation rate requirements are served by a common ventilation system, the ratio of outdoor air to total supply air for the system shall be determined based on the space having the

largest outdoor air requirement or shall be determined in accordance with the following formula:

$$Y = X/(1 + X - Z) \qquad \textbf{(Equation 2-1)}$$

where:

Y = V_{ot}/V_{st} = Corrected fraction of outdoor air in system supply.
X = V_{on}/V_{st} = Uncorrected fraction of outdoor air in system supply.
Z = V_{oc}/V_{sc} = Fraction of outdoor air in critical space (with the greatest required fraction of outdoor air).
V_{ot} = Corrected total outdoor airflow rate.
V_{st} = Total supply flow rate, i.e., the sum of all supply for all branches of the system.
V_{on} = Sum of outdoor airflow rates for all branches on system.
V_{oc} = Outdoor airflow rate required in critical spaces.
V_{sc} = Supply flow rate in critical space.

Table 2.3.3
Required Outdoor Ventilation Air

Occupancy Classification	Estimated Maximum Occupant Load, (Persons Per 100 Square Meter[a])	Outdoor Air (Liter Per Second Per Person) Unless Noted[e]
Correctional facilities		
Cells		
with plumbing fixtures	21	10
without plumbing fixtures	21	10
Dining halls	107	7.5
Guard stations	43	7.5
Dry Cleaners, laundries		
Coin-operated dry cleaner	21	7.5
Coin-operated laundries	21	7.5
Commercial dry cleaner	32	15
Commercial laundry	10	12
Storage, pick up	32	17
Education		
Auditoriums	160	7.5
Classrooms	53	7.5
Corridors	–	0.5 liter/sec. per m^2
Laboratories	32	10
Libraries	21	7.5
Locker rooms[b]	–	2.6 liter/sec. per m^2
Music rooms	53	7.5
Smoking lounges[b,g]	75	29
Training shops	32	15
Food and beverage service		
Lounges	110	15
Cafeteria, fast food	110	10
Dining rooms	75	10
Kitchens (cooking)[f,g]	21	7.5

(continued)

Table 2.3.3 (*continued*)
Required Outdoor Ventilation Air

Occupancy Classification	Estimated Maximum Occupant Load, (Persons Per 100 Square Meter[a])	Outdoor Air (Liter Per Second Per Person) Unless Noted[e]
Hospitals, nursing and convalescent homes		
Autopsy rooms[b]	–	2.6 liter/sec. per m^2
Medical procedure rooms	21	7.5
Operating rooms	21	15
Patient rooms	10	12
Physical therapy	21	7.5
Recovery and ICU	21	7.5
Hotels, motels, resorts and dormitories		
Assembly rooms	130	7.5
Bathrooms[b,g]	–	17 liter/sec. per room
Bedrooms	–	15 liter/sec. per room
Conference rooms	53	10
Dormitory sleeping areas	21	7.5
Living rooms		15 liter/sec. per room
Lobbies	32	7.5
Offices		
Conference rooms	53	10
Office spaces	7	10
Reception areas	64	7.5
Telecommunication centers and data entry	64	10
Private dwellings, single and multiple		
Living areas	Based upon number of bedrooms. first bedroom: 2; each additional bedroom:1	0.35 air changes per hour[a] or 8 liter/sec. per person whichever is greater
Kitchens[g]	–	48 liter/sec. intermittent or 12 liter/sec. continuous
Toilet rooms and bathrooms[g]	–	mechanical exhaust capacity of 24 liter/sec. intermittent or 10liter/sec.continuous
Garages, separate for each dwelling	–	48 liter/sec. per car
Garages, common for multiple units[b]	–	8 liter/sec. per m^2

(continued)

Table 2.3.3 (*continued*)
Required Outdoor Ventilation Air

Occupancy Classification	Estimated Maximum Occupant Load, (Persons Per 100 Square Meter[a])	Outdoor Air (Liter Per Second Per Person) Unless Noted[e]
Public spaces		
Corridors and utilities	–	0.26 liter/sec. per m^2
Elevators[g]	–	5.1 liter/sec.per m^2
Locker rooms[b]	–	2.6 liter/sec.per m^2
Toilet rooms[b,g]	–	36 liter/sec. per water closet
Shower room (per shower head)[b,g]		24 liter/sec. intermittent or 10liter/sec. continuous
Smoking lounges[b,g]	75	30
Retail stores, sales floors and Showroom floors		
Basement and street	–	1.6 liter/sec. per m^2
Dressing rooms	–	1.1 liter/sec. per m^2
Malls and arcades	–	1.1 liter/sec. per m^2
Shipping & receiving	–	0.8 liter/sec. per m^2
Smoking lounges[b]	75	30
Storage rooms	–	0.8 liter/sec. per m^2
Upper floors	–	1.1 liter/sec. per m^2
Warehouses	–	0.26 liter/sec. per m^2
Specialty shops		
Automotive service stations	–	8 liter/sec. per m^2
Barber	26	7.5
Beauty	26	12
Clothiers, furniture	–	1.6 liter/sec. per m^2
Florists	8	7.5
Hardware, drugs, fabrics	8	7.5
Pet shops	–	5.1 liter/sec. per m^2
Reducing salons	21	7.5
Supermarkets	8	7.5
Sports and amusement		
Gathering rooms	107	12
Bowling (seating areas)	75	12
Game rooms	75	12
Ice arenas	–	2.6 liter/sec. per m^2
Gymnasiums	32	10
Spectator areas	160	7.5
Swimming pools	–	2.6 liter/sec. per m^2
Storage		
Repair garages, enclosed parking garages[d]	–	8 liter/sec. per m^2
Warehouses	–	0.26 liter/sec. per m^2
Theaters		
Auditoriums	160	7.5
Lobbies	160	10
Stages, studios	75	7.5
Ticket booths	65	10

(continued)

Table 2.3.3 (*continued*)
Required Outdoor Ventilation Air

Occupancy Classification	Estimated Maximum Occupant Load, (Persons Per 100 Square Meter[a])	Outdoor Air (Liter Per Second Per Person) Unless Noted[e]
Transportation		
Platforms	110	7.5
Vehicles	160	7.5
Waiting rooms	110	7.5
Workrooms		
Bank safekeeping room	5	7.5
Darkrooms	–	2.6 liter/sec. per m^2
Duplicating, printing	–	2.6 liter/sec. per m^2
Meat processing	10	7.5
Pharmacy	21	7.5
Photo studios	10	7.5

a. Based upon net floor area.
b. Mechanical exhaust required and the recirculation of air from such spaces as permitted by Section 2.3.2.1 is prohibited (see Section 2.3.2.1).
c. Spaces unheated or maintained below 10°C are not covered by these requirements unless the occupancy is continuous.
d. Ventilation systems in enclosed parking garages shall comply with Section 2.4. A mechanical ventilation system shall not be required in garages having a floor area not exceeding 80 square meter and used for the storage of not more than four vehicles or trucks of 900 kg maximum capacity.
e. Where the ventilation rate is expressed in liter/sec. per m^2, such rate is based upon liter per second per square meter of the floor area being ventilated.
f. The sum of the outdoor and transfer air from adjacent spaces shall be sufficient to provide an exhaust rate of not less than 8 liter/sec. per m^2.
g. Transfer air permitted in accordance with Section 2.3.2.2.

2.3.3.3 **Variable air volume system control.** Variable air volume air distribution systems, other than those designed to supply only 100-percent outdoor air, shall be provided with controls to regulate the flow of outdoor air. Such control system shall be designed to maintain the flow of outdoor air at a rate of not less than that required by Section 2.3 over the entire range of supply air operating rates.

2.3.3.4 **Balancing.** Ventilation systems shall be balanced by an approved method. Such balancing shall verify that the ventilation system is capable of supplying the airflow rates required by Section 2.3.

2.3.3.5 **Balancing volume dampers on intake openings.** Balancing volume dampers are required on all fresh air intake openings to ensure minimum fresh air flow rate as specified in table 2.3.3.

SECTION 2.4
ENCLOSED PARKING GARAGES

2.4.1 **Enclosed parking garages.** Mechanical ventilation systems for enclosed parking garages are not required to operate continuously where the system is arranged to operate automatically upon detection of a concentration of carbon monoxide of 25 parts per million (ppm) by approved automatic detection devices.

2.4.2 **Minimum ventilation.** Automatic operation of the system shall not reduce the ventilation rate below 0.25 liter/sec. per square meter of the floor area and the system shall be capable of producing a ventilation rate of 7.6 liter/sec. per square meter of floor area.

2.4.3 **Occupied spaces accessory to public garages.** Connecting offices, waiting rooms, ticket booths and similar uses that are accessory to a public garage shall be maintained at a positive pressure and shall be provided with ventilation in accordance with Section 2.3.3.

SECTION 2.5
SYSTEMS CONTROL

2.5.1 **General.** Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied. Air-conditioning systems that supply required ventilation air shall be provided with controls designed to automatically maintain the required outdoor air supply rate during occupancy.

SECTION 2.6
VENTILATION OF UNINHABITED SPACES

2.6.1 **General.** Uninhabited spaces such as crawl spaces and attics, shall be provided with natural ventilation openings as required by the *Saudi Building Code Basic Regulations* or shall be provided with a mechanical exhaust and supply air system. The mechanical exhaust rate shall be not less than 0.01 liter/sec. per square meter of horizontal area.

SECTION 2.7
VENTILATION OF MOSQUES

2.7.1 **General.** Mosques shall be provided with natural ventilation openings. or shall be provided with a mechanical exhaust and supply air system. Mechanical ventilation systems shall be provided with automatic controls that will operate before and whenever the mosque is occupied. The minimum outdoor air supply rate shall be 15 Liter/sec. per person. For air-conditioned Mosques with capacity exceeds 200 persons, Economizer or Demand control ventilation and Heat recovery systems shall be provided.

CHAPTER 3
EXHAUST SYSTEMS

SECTION 3.1
GENERAL

3.1.1 **Scope.** This chapter shall govern the design, construction and installation of mechanical exhaust systems, including dust, stock and refuse conveyor systems, exhaust systems serving commercial cooking appliances and energy recovery ventilation systems.

3.1.2 **Outdoors discharge.** The air removed by every mechanical exhaust system shall be discharged outdoors at a point where it will not cause a nuisance and from which it cannot again be readily drawn in by a ventilating system. Air shall not be exhausted into an attic or crawl space.

Exceptions:

1. Whole-house ventilation-type attic fans that discharge into the attic space of dwelling units having private attics.
2. Commercial cooking re-circulating systems.

3.1.3 **Pressure equalization.** Mechanical exhaust systems shall be sized to remove the quantity of air required by this chapter to be exhausted. The system shall operate when air is required to be exhausted. Where mechanical exhaust is required in a room or space in other than occupancies in Group R-3, such space shall be maintained with a neutral or negative pressure. If a greater quantity of air is supplied by a mechanical ventilating supply system than is removed by a mechanical exhaust system for a room, adequate means shall be provided for the natural exit of the excess air supplied. If only a mechanical exhaust system is installed for a room or if a greater quantity of air is removed by a mechanical exhaust system than is supplied by a mechanical ventilating supply system for a room, adequate means shall be provided for the natural supply of the deficiency in the air supplied.

3.1.4 **Ducts.** Where exhaust duct construction is not specified in this chapter, such construction shall comply with Chapter 4.

SECTION 3.2
REQUIRED SYSTEMS

3.2.1 **General.** An exhaust system shall be provided, maintained and operated as specifically required by this section and for all occupied areas where machines, vats, tanks, furnaces, forges, salamanders and other appliances, equipment and processes in such areas produce or throw off dust or particles sufficiently light to float in the air, or which emit heat, odors, fumes, spray, gas or smoke, in such quantities so as to be irritating or injurious to health or safety.

3.2.1.1 **Exhaust location.** The inlet to an exhaust system shall be located in the area of heaviest concentration of contaminants.

3.2.1.2 **Fuel-dispensing areas.** The bottom of an air inlet or exhaust opening in fuel-dispensing areas shall be located not more than 460 mm above the floor.

3.2.1.3 **Equipment, appliance and service rooms.** Equipment, appliance and system service rooms that house sources of odors, fumes, noxious gases, smoke, steam, dust, spray or other contaminants shall be designed and constructed so as to prevent spreading of such contaminants to other occupied parts of the building.

3.2.1.4 **Hazardous exhaust.** The mechanical exhaust of high concentrations of dust or hazardous vapors shall conform to the requirements of Section 3.10.

3.2.2 **Aircraft fueling and defueling.** Compartments housing piping, pumps, air eliminators, water separators, hose reels and similar equipment used in aircraft fueling and defueling operations shall be adequately ventilated at floor level or within the floor itself.

3.2.3 **Battery-charging areas.** Ventilation shall be provided in an approved manner in battery-charging areas to prevent a dangerous accumulation of flammable gases.

3.2.4 **Stationary lead-acid battery systems.** Ventilation shall be provided for stationary lead-acid battery systems in accordance with this chapter and Section 3.2.4.1 or 3.2.4.2.

3.2.4.1 **Hydrogen limit.** The ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room.

3.2.4.2 **Ventilation rate.** Continuous ventilation shall be provided at a rate of not less than 0.005 $m^3/(s \cdot m^2)$ of floor area of the room.

3.2.5 **Valve-regulated lead-acid batteries.** Valve-regulated lead-acid battery systems as regulated by the Saudi Fire Requirements shall be provided with ventilation in accordance with Section 3.2.5.1 or 3.2.5.2 for rooms and in accordance with Section 3.2.5.3 or 3.2.5.4 for cabinets.

3.2.5.1 **Hydrogen limit in rooms.** The ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the room during the worst-case event of simultaneous boost charging of all batteries in the room.

3.2.5.2 **Ventilation rate in rooms.** Continuous ventilation shall be provided at a rate of not less than 0.005 $m^3/(s \cdot m^2)$ of floor area of the room.

3.2.5.3 **Hydrogen limit in cabinets.** The ventilation system shall be designed to limit the maximum concentration of hydrogen to 1.0 percent of the total volume of the cabinet during the worst-case event of simultaneous boost charging of all batteries in the cabinet.

3.2.5.4 **Ventilation rate in cabinets.** Continuous ventilation shall be provided at a rate of not less than 0.005 $m^3/(s \cdot m^2)$ of the floor area covered by the cabinet. The room in which the cabinet is installed shall also be ventilated as required by Section 3.2.5.1 or 3.2.5.2.

3.2.6 **Dry cleaning plants.** Ventilation in dry cleaning plants shall be adequate to protect employees and the public in accordance with this section.

3.2.6.1 **Type II systems.** Type II dry cleaning systems shall be provided with a mechanical ventilation system that is designed to exhaust 0.005 $m^3/(s \cdot m^2)$ in dry cleaning rooms and in drying rooms. The ventilation system shall operate automatically when the dry cleaning equipment is in operation and shall have manual controls at an approved location.

3.2.6.2 **Type IV and V systems**. Type IV and V dry cleaning systems shall be provided with an automatically activated exhaust ventilation system to maintain a minimum of 0.5 m/s air velocity through the loading door when the door is opened.

Exception: Dry cleaning units are not required to be provided with exhaust ventilation where an exhaust hood is installed immediately outside of and above the loading door which operates at an airflow rate as follows:

$$Q = 0.5 \times ALD \qquad \textbf{(Equation 3-1)}$$

where:

Q = Flow rate exhausted through the hood, m^3/s.

ALD = Area of the loading door, m^2.

3.2.6.3 **Spotting and pre-treating.** Scrubbing tubs, scouring, brushing or spotting operations shall be located such that solvent vapors are captured and exhausted by the ventilating system.

3.2.7 **Application of flammable finishes.** Mechanical exhaust as required by this section shall be provided for operations involving the application of flammable finishes.

3.2.7.1 **During construction.** Ventilation shall be provided for operations involving the application of materials containing flammable solvents in the course of construction, alteration or demolition of a structure.

3.2.7.2 **Limited spraying spaces.** Positive mechanical ventilation which provides a minimum of six complete air changes per hour shall be installed in limited spraying spaces. Such system shall meet the requirements of the Saudi Fire Requirements for handling flammable vapors. Explosion venting is not required.

3.2.7.3 **Spraying areas.** Mechanical ventilation of spraying areas shall be provided in accordance with Sections 3.2.7.3.1 through 3.2.7.3.7.

3.2.7.3.1 **Operation.** Mechanical ventilation shall be kept in operation at all times while spraying operations are being conducted and for a sufficient time thereafter to allow vapors from drying coated articles and finishing material residue to be exhausted. Spraying equipment shall be interlocked with the ventilation of the spraying area such that spraying cannot be conducted unless the ventilation system is in operation.

3.2.7.3.2 **Recirculation.** Air exhausted from spraying operations shall not be recirculated.

Exceptions:

1. Air exhausted from spraying operations shall be permitted to be recirculated as makeup air for unmanned spray operations provided that:
   - 1.1 Solid particulate has been removed.
   - 1.2 The vapor concentration is less than 25 percent of the lower flammability limit (LFL).
   - 1.3 Approved equipment is used to monitor the vapor concentration.
   - 1.4 An alarm is sounded and spray operations are automatically shut down if the vapor concentration exceeds 25 percent of the LFL.
   - 1.5 The spray booths, spray spaces or spray rooms involved in any recirculation process shall be provided with mechanical ventilation that shall automatically exhaust 100 percent of the required air volume in the event of shutdown by approved equipment used to monitor vapor concentrations.

2. Air exhausted from spraying operations shall be permitted to be recirculated as makeup air to manned spraying operations if all of the conditions provided in Exception 1 are included in the installation and documents have been prepared to show that the installation does not present life safety hazards to personnel inside the spray booth, spray space or spray room.

3.2.7.3.3 **Air velocity.** Ventilation systems shall be designed, installed and maintained such that the average air velocity over the open face of the booth, or booth cross section in the direction of airflow during spraying operations, is not less than 0.5 m/s.

3.2.7.3.4 **Ventilation obstruction.** Articles being sprayed shall be positioned in a manner that does not obstruct collection of overspray.

3.2.7.3.5 **Independent ducts.** Each spray booth and spray room shall have an independent exhaust duct system discharging to the outdoors.

Exceptions:

1. Multiple spray booths having a combined frontal area of 1.7 m^2 or less are allowed to have a common exhaust where identical spray-finishing material is used in each booth. If more than one fan serves one booth, such fans shall be interconnected so that all fans operate simultaneously.
2. Where treatment of exhaust is necessary for air pollution control or energy conservation, ducts shall be allowed to be manifolded if all of the following conditions are met:
   2.1 The sprayed materials used are compatible and will not react or cause ignition of the residue in the ducts.
   2.2 Nitrocellulose-based finishing material shall not be used.
   2.3 A filtering system shall be provided to reduce the amount of overspray carried into the duct manifold.
   2.4 Automatic sprinkler protection shall be provided at the junction of each booth exhaust with the manifold, in addition to the protection required by this chapter.

3.2.7.3.6 **Termination point.** The termination point for exhaust ducts discharging to the atmosphere shall be located with the following minimum distances:

1. For ducts conveying explosive or flammable vapors, fumes or dusts: 9.0 m from the property line; 3.0 m from openings into the building; 1.8 m from exterior walls and roofs; 9.0 m from combustible walls and openings into the building which are in the direction of the exhaust discharge; 3.0 m above adjoining grade.
2. For other product-conveying outlets: 3.0 m from the property line; 900 mm from exterior walls and roofs; 3.0 m from openings into the building; 3.0 m above adjoining grade.
3. For environmental air duct exhaust: 900 mm from the property line; 900 mm from openings into the building.

3.2.7.3.7 **Fan motors and belts.** Electric motors driving exhaust fans shall not be placed inside booths or ducts. Fan rotating elements shall be nonferrous or nonsparking or the casing shall consist of, or be lined with, such material. Belts shall not enter the duct or booth unless the belt and pulley within the duct are tightly enclosed.

3.2.7.4 **Dipping operations.** Vapor areas of dip tank operations shall be provided with mechanical ventilation adequate to prevent the dangerous accumulation of vapors. Required ventilation systems shall be so arranged that the failure of any ventilating fan will automatically stop the dipping conveyor system.

3.2.7.5 **Electrostatic apparatus.** The spraying area in spray-finishing operations involving electrostatic apparatus and devices shall be ventilated in accordance with Section 3.2.7.3.

3.2.7.6 **Powder coating.** Exhaust ventilation for powder-coating operations shall be sufficient to maintain the atmosphere below one-half of the minimum explosive concentration for the material being applied. Nondeposited, air-suspended powders shall be removed through exhaust ducts to the powder recovery cyclone or receptacle.

3.2.7.7 **Floor resurfacing operations**. To prevent the accumulation of flammable vapors during floor resurfacing operations, mechanical ventilation at a minimum rate of 0.005 $m^3/(s{\cdot}m^2)$ of area being finished shall be provided. Such exhaust shall be by approved temporary or portable means. Vapors shall be exhausted to the exterior of the building.

3.2.8 **Hazardous materials general requirements**. Exhaust ventilation systems for structures containing hazardous materials shall be provided as required in Sections 3.2.8.1 through 3.2.8.5.

3.2.8.1 **Storage in excess of the maximum allowable quantities.** Indoor storage areas and storage buildings for hazardous materials in amounts exceeding the maximum allowable quantity per control area shall be provided with mechanical exhaust ventilation or natural ventilation where natural ventilation can be shown to be acceptable for the materials as stored.

Exception: Storage areas for flammable solids complying with the Saudi Building Code Fire Requirements.

3.2.8.1.1 **System requirements.** Exhaust ventilation systems shall comply with all of the following:

1. The installation shall be in accordance with these requirements.
2. Mechanical ventilation shall be provided at a rate of not less than 0.005 $m^3/(s{\cdot}m^2)$ of floor area over the storage area.
3. The systems shall operate continuously unless alternate designs are approved.
4. A manual shutoff control shall be provided outside of the room in a position adjacent to the access door to the room or in another approved location. The switch shall be of the break-glass type and shall be labeled: VENTILATION SYSTEM EMERGENCY SHUTOFF.
5. The exhaust ventilation system shall be designed to consider the density of the potential fumes or vapors released. For fumes or vapors that are heavier than air, exhaust shall be taken from a point within 300 mm of the floor.
6. The location of both the exhaust and inlet air openings shall be designed to provide air movement across all portions of the floor or room to prevent the accumulation of vapors.
7. The exhaust ventilation shall not be recirculated within the room or building if the materials stored are capable of emitting hazardous vapors.

3.2.8.2 **Gas rooms, exhausted enclosures and gas cabinets.** The ventilation system for gas rooms, exhausted enclosures and gas cabinets for any quantity of hazardous material shall be designed to operate at a negative pressure in relation to the surrounding area. Highly toxic and toxic gases shall also comply with Sections 3.2.9.7.1, 3.2.9.7.2 and 3.2.9.8.4.

3.2.8.3 **Indoor dispensing and use.** Indoor dispensing and use areas for hazardous materials in amounts exceeding the maximum allowable quantity per control area shall be provided with exhaust ventilation in accordance with Section 3.2.7.1.

Exception: Ventilation is not required for dispensing and use of flammable solids other than finely divided particles.

3.2.8.4 **Indoor dispensing and use point sources**. Where gases, liquids or solids in amounts exceeding the maximum allowable quantity per control area and having a hazard ranking of 3 or 4 in accordance with (NFPA 704) are dispensed or used, mechanical exhaust ventilation shall be provided to capture fumes, mists or vapors at the point of generation.

Exception: Where it can be demonstrated that the gases, liquids or solids do not create harmful fumes, mists or vapors.

3.2.8.5 **Closed systems.** Where closed systems for the use of hazardous materials in amounts exceeding the maximum allowable quantity per control area are designed to be opened as part of normal operations, ventilation shall be provided in accordance with Section 3.2.8.4.

3.2.9 **Hazardous materials - requirements for specific materials.** Exhaust ventilation systems for specific hazardous materials shall be provided as required in Section 3.2.8 and Sections 3.2.9.1 through 3.2.9.11.

3.2.9.1 **Compressed gases - medical gas systems.** Rooms for the storage of compressed medical gases in amounts exceeding the maximum allowable exempt quantity per control area, and which do not have an exterior wall, shall be exhausted through a

duct to the exterior of the building. Both separate airstreams shall be enclosed in a 1-hour-rated shaft enclosure from the room to the exterior. Approved mechanical ventilation shall be provided at a minimum rate of 0.005 $m^3/(s\cdot m^2)$ of the area of the room. Gas cabinets for the storage of compressed medical gases in amounts exceeding the maximum allowable quantity per control area shall be connected to an exhaust system. The average velocity of ventilation at the face of access ports or windows shall be not less than 1.0 m/s with a minimum velocity of 0.75 m/s at any point at the access port or window.

3.2.9.2 **Corrosives.** Where corrosive materials in amounts exceeding the maximum allowable quantity per control area are dispensed or used, mechanical exhaust ventilation in accordance with Section 3.2.8.4 shall be provided.

3.2.9.3 **Cryogenics.** Storage areas for stationary or portable containers of cryogenic fluids in any quantity shall be ventilated in accordance with Section 3.2.8. Indoor areas where cryogenic fluids in any quantity are dispensed shall be ventilated in accordance with the requirements of Section 3.2.8.4 in a manner that captures any vapor at the point of generation.

Exception: Ventilation for indoor dispensing areas is not required where it can be demonstrated that the cryogenic fluids do not create harmful vapors.

3.2.9.4 **Explosives.** Squirrel cage blowers shall not be used for exhausting hazardous fumes, vapors or gases in operating buildings and rooms for the manufacture, assembly or testing of explosives. Only nonferrous fan blades shall be used for fans located within the ductwork and through which hazardous materials are exhausted. Motors shall be located outside the duct.

3.2.9.5 **Flammable and combustible liquids.** Exhaust ventilation systems shall be provided as required by Sections 3.2.9.5.1 through 3.2.9.5.5 for the storage, use, dispensing, mixing and handling of flammable and combustible liquids. Unless otherwise specified, this section shall apply to any quantity of flammable and combustible liquids.

Exception: This section shall not apply to flammable and combustible liquids that are exempt from the Saudi Fire Requirements.

3.2.9.5.1 **Vaults.** Vaults that contain tanks of Class I liquids shall be provided with continuous ventilation at a rate of not less than 0.005 $m^3/(s\cdot m^2)$ of floor area, but not less than 4 m^3/min. Failure of the exhaust airflow shall automatically shut down the dispensing system. The exhaust system shall be designed to provide air movement across all parts of the vault floor. Supply and exhaust ducts shall extend to a point not greater than 300 mm and not less than 75 mm above the floor. The exhaust system shall be installed in accordance with the provisions of (NFPA 91). Means shall be provided to automatically detect any flammable vapors and to automatically shut down the dispensing system upon detection of such flammable vapors in the exhaust duct at a concentration of 25 percent of the LFL.

3.2.9.5.2 **Storage rooms and warehouses.** Liquid storage rooms and liquid storage warehouses for quantities of liquids exceeding those specified in the Saudi Fire Requirements shall be ventilated in accordance with Section 3.2.8.1.

3.2.9.5.3 **Cleaning machines.** Areas containing machines used for parts cleaning in accordance with the Saudi Fire Requirements shall be adequately ventilated to prevent accumulation of vapors.

3.2.9.5.4 **Use, dispensing and mixing.** Continuous mechanical ventilation shall be provided for the use, dispensing and mixing of flammable and combustible liquids in open or closed systems in amounts exceeding the maximum allowable quantity per control area and for bulk transfer and process transfer operations. The ventilation rate shall be not less than 0.005 $m^3/(s\cdot m^2)$ of floor area over the design area. Provisions shall be made for the introduction of makeup air in a manner that will

include all floor areas or pits where vapors can collect. Local or spot ventilation shall be provided where needed to prevent the accumulation of hazardous vapors.

Exception: Where natural ventilation can be shown to be effective for the materials used, dispensed, or mixed.

3.2.9.5.5 **Bulk plants or terminals.** Ventilation shall be provided for portions of properties where flammable and combustible liquids are received by tank vessels, pipelines, tank cars or tank vehicles and which are stored or blended in bulk for the purpose of distributing such liquids by tank vessels, pipelines, tank cars, tank vehicles or containers as required by Sections 3.2.9.5.5.1 through 3.2.9.5.5.3.

3.2.9.5.5.1 **General.** Ventilation shall be provided for rooms, buildings and enclosures in which Class I liquids are pumped, used or transferred. Design of ventilation systems shall consider the relatively high specific gravity of the vapors. Where natural ventilation is used, adequate openings in outside walls at floor level, unobstructed except by louvers or coarse screens, shall be provided. Where natural ventilation is inadequate, mechanical ventilation shall be provided.

3.2.9.5.5.2 **Basements and pits.** Class I liquids shall not be stored or used within a building having a basement or pit into which flammable vapors can travel, unless such area is provided with ventilation designed to prevent the accumulation of flammable vapors therein.

3.2.9.5.5.3 **Dispensing of Class I liquids.** Containers of Class I liquids shall not be drawn from or filled within buildings unless a provision is made to prevent the accumulation of flammable vapors in hazardous concentrations. Where mechanical ventilation is required, it shall be kept in operation while flammable vapors could be present.

3.2.9.6 **Highly toxic and toxic liquids.** Ventilation exhaust shall be provided for highly toxic and toxic liquids as required by Sections 3.2.9.6.1 and 3.2.9.6.2.

3.2.9.6.1 **Treatment system.** This provision shall apply to indoor and outdoor storage and use of highly toxic and toxic liquids in amounts exceeding the maximum allowable quantities per control area. Exhaust scrubbers or other systems for processing vapors of highly toxic liquids shall be provided where a spill or accidental release of such liquids can be expected to release highly toxic vapors at normal temperature and pressure.

3.2.9.6.2 **Open and closed systems.** Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in open systems in accordance with Section 3.2.8.4. Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in closed systems in accordance with Section 3.2.8.5.

Exception: Liquids or solids that do not generate highly toxic or toxic fumes, mists or vapors.

3.2.9.7 **Highly toxic and toxic compressed gases-any quantity**. Ventilation exhaust shall be provided for highly toxic and toxic compressed gases in any quantity as required by Sections 3.2.9.7.1 and 3.2.9.7.2.

3.2.9.7.1 **Gas cabinets.** Gas cabinets containing highly toxic or toxic compressed gases in any quantity shall comply with Section 3.2.8.2 and the following requirements:

1. The average ventilation velocity at the face of gas cabinet access ports or windows shall be not less than 1.0 m/s with a minimum velocity of 0.75 m/s at any point at the access port or window.
2. Gas cabinets shall be connected to an exhaust system.
3. Gas cabinets shall not be used as the sole means of exhaust for any room or area.

3.2.9.7.2 **Exhausted enclosures.** Exhausted enclosures containing highly toxic or toxic compressed gases in any quantity shall comply with Section 3.2.8.2 and the following requirements:

1. The average ventilation velocity at the face of the enclosure shall be not less than 1.0 m/s with a minimum velocity of 0.75 m/s.
2. Exhausted enclosures shall be connected to an exhaust system.
3. Exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

3.2.9.8 **Highly toxic and toxic compressed gases. Quantities exceeding the maximum allowable per control area.** Ventilation exhaust shall be provided for highly toxic and toxic compressed gases in amounts exceeding the maximum allowable quantities per control area as required by Sections 3.2.9.8.1 through 3.2.9.8.6.

3.2.9.8.1 **Ventilated areas.** The room or area in which indoor gas cabinets or exhausted enclosures are located shall be provided with exhaust ventilation. Gas cabinets or exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

3.2.9.8.2 **Local exhaust for portable tanks.** A means of local exhaust shall be provided to capture leakage from indoor and outdoor portable tanks. The local exhaust shall consist of portable ducts or collection systems designed to be applied to the site of a leak in a valve or fitting on the tank. The local exhaust system shall be located in a gas room. Exhaust shall be directed to a treatment system where required by the Saudi Fire Requirements.

3.2.9.8.3 **Piping and controls. Stationary tanks.** Filling or dispensing connections on indoor stationary tanks shall be provided with a means of local exhaust. Such exhaust shall be designed to capture fumes and vapors. The exhaust shall be directed to a treatment system where required by the Saudi Fire Requirements.

3.2.9.8.4 **Gas rooms.** The ventilation system for gas rooms shall be designed to operate at a negative pressure in relation to the surrounding area. The exhaust ventilation from gas rooms shall be directed to an exhaust system.

3.2.9.8.5 **Treatment system.** The exhaust ventilation from gas cabinets, exhausted enclosures and gas rooms, and local exhaust systems required in Sections 3.2.9.8.2 and 3.2.9.8.3 shall be directed to a treatment system where required by the Saudi Fire Requirements.

3.2.9.8.6 **Process equipment.** Effluent from indoor and outdoor process equipment containing highly toxic or toxic compressed gases which could be discharged to the atmosphere shall be processed through an exhaust scrubber or other processing system. Such systems shall be in accordance with the Saudi Fire Requirements.

3.2.9.9 **Ozone gas generators.** Ozone cabinets and ozone gas-generator rooms for systems having a maximum ozone-generating capacity of 0.25 kg or more over a 24-hour period shall be mechanically ventilated at a rate of not less than six air changes per hour. For cabinets, the average velocity of ventilation at makeup air openings with cabinet doors closed shall be not less than 1.0 m/s.

3.2.9.10 **LP-gas distribution facilities.** LP-gas distribution facilities shall be ventilated in accordance with (NFPA 58).

3.2.9.10.1 **Portable container use.** Above-grade underfloor spaces or basements in which portable LP-gas containers are used or are stored awaiting use or re-sale shall be provided with an approved means of ventilation.

Exception: Cylinders with a maximum water capacity of 1 kg for use in completely self-contained hand torches and similar applications. The quantity of LP-gas shall not exceed 9 kg.

3.2.9.11 **Silane gas.** Exhausted enclosures and gas cabinets for the indoor storage of silane gas in amounts exceeding the maximum allowable quantities per control area shall comply with this section.

1. Exhausted enclosures and gas cabinets shall be in accordance with Section 3.2.8.2.

2. The velocity of ventilation across unwelded fittings and connections on the piping system shall not be less than 1.0 m/s.
3. The average velocity at the face of the access ports or windows in the gas cabinet shall not be less than 1.0 m/s with a minimum velocity of 0.75 m/s at any point at the access port or window.

3.2.10 **Hazardous production materials (HPM).** Exhaust ventilation systems and materials for ducts utilized for the exhaust of HPM shall comply with this section, other applicable provisions of these requirements, the Saudi Building Code and the Saudi Fire Requirements.

3.2.10.1 **Where required.** Exhaust ventilation systems shall be provided in the following locations in accordance with the requirements of this section and the Saudi Building Code:

1. Fabrication areas: Exhaust ventilation for fabrication areas shall comply with the Saudi Building Code. Additional manual control switches shall be provided where required by the code official.
2. Workstations: A ventilation system shall be provided to capture and exhaust fumes and vapors at workstations.
3. Liquid storage rooms: Exhaust ventilation for liquid storage rooms shall comply with Section 3.2.8.1.1 and the Saudi Building Code.
4. HPM rooms: Exhaust ventilation for HPM rooms shall comply with Section 3.2.8.1.1 and the Saudi Building Code.
5. Gas cabinets: Exhaust ventilation for gas cabinets shall comply with Section 3.2.8.2. The gas cabinet ventilation system is allowed to connect to a workstation ventilation system. Exhaust ventilation for gas cabinets containing highly toxic or toxic gases shall also comply with Sections 3.2.9.7 and 3.2.9.8.
6. Exhausted enclosures: Exhaust ventilation for exhausted enclosures shall comply with Section 3.2.7.2. Exhaust ventilation for exhausted enclosures containing highly toxic or toxic gases shall also comply with Sections 3.2.9.7 and 3.2.9.8.
7. Gas rooms: Exhaust ventilation for gas rooms shall comply with Section 3.2.8.2. Exhaust ventilation for gas cabinets containing highly toxic or toxic gases shall also comply with Sections 3.2.9.7 and 3.2.9.8.

3.2.10.2 **Penetrations**. Exhaust ducts penetrating fire barrier assemblies shall be contained in a shaft of equivalent fire-resistive construction. Exhaust ducts shall not penetrate building separation walls. Fire dampers shall not be installed in exhaust ducts.

3.2.10.3 **Treatment systems.** Treatment systems for highly toxic and toxic gases shall comply with the Saudi Fire Requirements.

3.2.11 **Motion picture projectors.** Motion picture projectors shall be exhausted in accordance with Section 3.2.11.1 or 3.2.11.2.

3.2.11.1 **Projectors with an exhaust discharge.** Projectors equipped with an exhaust discharge shall be directly connected to a mechanical exhaust system. The exhaust system shall operate at an exhaust rate as indicated by the manufacturer's installation instructions.

3.2.11.2 **Projectors without exhaust connection.** Projectors without an exhaust connection shall have contaminants exhausted through a mechanical exhaust system. The exhaust rate for electric arc projectors shall be a minimum of 0.1 m^3/s feet per lamp. The exhaust rate for xenon projectors shall be a minimum of 0.15 m^3/s per lamp. Xenon projector exhaust shall be at a rate such that the exterior temperature of the lamp housing does not exceed 55^{o}C. The lamp and projection

room exhaust systems, whether combined or independent, shall not be interconnected with any other exhaust or return system within the building.

3.2.12 **Organic coating processes.** Enclosed structures involving organic coating processes in which Class I liquids are processed or handled shall be ventilated at a rate of not less than 0.005 $m^3/(s \cdot m^2)$ of solid floor area. Ventilation shall be accomplished by exhaust fans that intake at floor levels and discharge to a safe location outside the structure. Non-contaminated intake air shall be introduced in such a manner that all portions of solid floor areas are provided with continuous uniformly distributed air movement.

3.2.13 **Public garages.** Mechanical exhaust systems for public garages, as required in Chapter 2, shall operate continuously or in accordance with Section 2.4.

3.2.14 **Motor vehicle operation.** In areas where motor vehicles operate, mechanical ventilation shall be provided in accordance with Section 4.3. Additionally, areas in which stationary motor vehicles are operated shall be provided with a source capture system that connects directly to the motor vehicle exhaust systems.

Exceptions:

1. This section shall not apply where the motor vehicles being operated or repaired are electrically powered.
2. This section shall not apply to one- and two-family dwellings.
3. This section shall not apply to motor vehicle service areas where engines are operated inside the building only for the duration necessary to move the motor vehicles in and out of the building.

3.2.15 **Repair garages.** Where Class I liquids or LP-gas are stored or used within a building having a basement or pit wherein flammable vapors could accumulate, the basement or pit shall be provided with ventilation designed to prevent the accumulation of flammable vapors therein.

3.2.16 **Repair garages for natural gas- and hydrogen-fueled vehicles.** Repair garages used for the repair of natural gas- or hydrogen-fueled vehicles shall be provided with an approved mechanical ventilation system. The mechanical ventilation system shall be in accordance with Sections 3.2.16.1 and 3.2.16.2.

Exception: Where approved by the code official, natural ventilation shall be permitted in lieu of mechanical ventilation.

3.2.16.1 **Design.** Indoor locations shall be ventilated utilizing air supply inlets and exhaust outlets arranged to provide uniform air movement to the extent practical. Inlets shall be uniformly arranged on exterior walls near floor level. Outlets shall be located at the high point of the room in exterior walls or the roof.

1. Ventilation shall be by a continuous mechanical ventilation system or by a mechanical ventilation system activated by a continuously monitoring natural gas detection system activating at a gas concentration of 25 percent of the LFL. In all cases, the system shall shut down the fueling system in the event of failure of the ventilation system.
2. The ventilation rate shall be at least 0.0014 $m^3/(s \cdot m^3)$ of room volume.

3.2.16.2 **Operation.** The mechanical ventilation system shall operate continuously.

Exceptions:

1. Mechanical ventilation systems that are interlocked with a gas detection system designed in accordance with the Saudi Fire Requirements.

2. Mechanical ventilation systems in garages that are used only for the repair of vehicles fueled by liquid fuels or odorized gases, such as CNG, where the ventilation system is electrically interlocked with the lighting circuit.

3.2.17 **Tire rebuilding or recapping.** Each room where rubber cement is used or mixed, or where flammable or combustible solvents are applied, shall be ventilated in accordance with the applicable provisions of (NFPA 91).

3.2.17.1 **Buffing machines.** Each buffing machine shall be connected to a dust-collecting system that prevents the accumulation of the dust produced by the buffing process.

3.2.18 **Specific rooms.** Specific rooms, including bathrooms, locker rooms, smoking lounges and toilet rooms shall be exhausted in accordance with the ventilation requirements of Chapter (2).

SECTION 3.3
MOTORS AND FANS

3.3.1 **General.** Motors and fans shall be sized to provide the required air movement. Motors in areas that contain flammable vapors or dusts shall be of a type approved for such environments. A manually operated remote control installed at an approved location shall be provided to shutoff fans or blowers in flammable vapor or dust systems. Electrical equipment and appliances used in operations that generate explosive or flammable vapors, fumes or dusts shall be interlocked with the ventilation system so that the equipment and appliances cannot be operated unless the ventilation fans are in operation. Motors for fans used to convey flammable vapors or dusts shall be located outside the duct or shall be protected with approved shields and dust-proofing. Motors and fans shall be provided with a means of access for servicing and maintenance.

3.3.2 **Fans.** Parts of fans in contact with explosive or flammable vapors, fumes or dusts shall be of nonferrous or non-sparking materials or their casing shall be lined or constructed of such material. When the size and hardness of materials passing through a fan are capable of producing a spark, both the fan and the casing shall be of non-sparking materials. When fans are required to be spark resistant, their bearings shall not be within the air stream, and all parts of the fan shall be grounded. Fans in systems-handling materials that are capable of clogging the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

3.3.3 **Equipment and appliances identification plate.** Equipment and appliances used to exhaust explosive or flammable vapors, fumes or dusts shall bear an identification plate stating the ventilation rate for which the system was designed.

3.3.4 **Corrosion-resistant fans.** Fans located in systems conveying corrosives shall be of materials that are resistant to the corrosive or shall be coated with corrosion-resistant materials.

SECTION 3.4
CLOTHES DRYER EXHAUST

3.4.1 **Installation.** Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer exhaust systems shall be independent of all

other systems and shall convey the moisture and any products of combustion to the outside of the building.

Exception: This section shall not apply to listed and labeled condensing (ductless) clothes dryers.

3.4.2 **Exhaust penetrations.** Ducts that exhaust clothes dryers shall not penetrate or be located within any fire-blocking, draft-stopping or any wall, floor/ceiling or other assembly required by the Saudi Building Code to be fire-resistance rated, unless such duct is constructed of galvanized steel or aluminum of the thickness specified in Section 4.3.4 and the fire-resistance rating is maintained in accordance with the Saudi Building Code. Fire dampers, combination fire/smoke dampers and any similar devices that will obstruct the exhaust flow, shall be prohibited in clothes dryer exhaust ducts.

3.4.3 **Cleanout.** Each vertical riser shall be provided with a means for cleanout.

3.4.4 **Exhaust installation.** Dryer exhaust ducts for clothes dryers shall terminate on the outside of the building and shall be equipped with a back draft damper. Screens shall not be installed at the duct termination. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the exhaust flow. Clothes dryer exhaust ducts shall not be connected to a vent connector, vent or chimney. Clothes dryer exhaust ducts shall not extend into or through ducts or plenums.

3.4.5 **Makeup air.** Installations exhausting more than 0.1 m^3/s shall be provided with makeup air. Where a closet is designed for the installation of a clothes dryer, an opening having an area of not less than 0.065 m^2 shall be provided in the closet enclosure.

3.4.6 **Domestic clothes dryer ducts.** Exhaust ducts for domestic clothes dryers shall be constructed of metal and shall have a smooth interior finish. The exhaust duct shall be a minimum nominal size of 100 mm in diameter. The entire exhaust system shall be supported and secured in place. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not to exceed 2440 mm and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

3.4.6.1 **Maximum length.** The maximum length of a clothes dryer exhaust duct shall not exceed 7.6 m from the dryer location to the outlet terminal. The maximum length of duct shall be reduced 750 mm for each 45-degree (0.79 rad) bend and 1.5 m for each 90-degree (1.6 rad) bend. The maximum length of the exhaust duct does not include the transition duct.

Exception: Where the make and model of the clothes dryer to be installed is known and the manufacturer's installation instructions for such dryer are provided to the code official, the maximum length of the exhaust duct, including any transition duct, shall be permitted to be in accordance with the dryer manufacturer's installation instructions.

3.4.6.2 **Rough-in required.** Where a compartment or space for domestic clothes dryer is provided, an exhaust duct system shall be installed in accordance with Sections 3.4.6 and 3.4.6.1.

3.4.7 **Commercial clothes dryers.** The installation of dryer exhaust ducts serving Type 2 clothes dryers shall comply with the appliance manufacturer's installation

instructions. Exhaust fan motors installed in exhaust systems shall be located outside of the air-stream. In multiple installations, the fan shall operate continuously or be interlocked to operate when any individual unit is operating. Ducts shall have a minimum clearance of 150 mm to combustible materials. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not to exceed 2.4 m in length and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

SECTION 3.5
DOMESTIC KITCHEN EXHAUST EQUIPMENT

3.5.1 **Domestic systems.** Where domestic range hoods and domestic appliances equipped with downdraft exhaust are located within dwelling units, such hoods and appliances shall discharge to the outdoors through ducts constructed of galvanized steel, stainless steel, aluminum or copper. Such ducts shall have smooth inner walls and shall be air tight and equipped with a back draft damper.

Exceptions:

1. Where installed in accordance with the manufacturer's installation instructions and where mechanical or natural ventilation is otherwise provided in accordance with Chapter 2, listed and labeled ductless range hoods shall not be required to discharge to the outdoors.

2. Ducts for domestic kitchen cooking appliances equipped with downdraft exhaust systems shall be permitted to be constructed of Schedule 40 PVC pipe provided that the installation complies with all of the following:

2.1 The duct shall be installed under a concrete slab poured on grade.

2.2 The under floor trench in which the duct is installed shall be completely backfilled with sand or gravel.

2.3 The PVC duct shall extend not greater than 25 mm above the indoor concrete floor surface.

2.4 The PVC duct shall extend not greater than 25 mm above grade outside of the building.

2.5 The PVC ducts shall be solvent cemented.

SECTION 3.6
COMMERCIAL KITCHEN HOOD VENTILATION SYSTEM DUCTS AND EXHAUST EQUIPMENT

3.6.1 **General.** Commercial kitchen hood ventilation ducts and exhaust equipment shall comply with the requirements of this section. Commercial kitchen grease ducts shall be designed for the type of cooking appliance and hood served.

3.6.2 **Corrosion protection.** Ducts exposed to the outside atmosphere or subject to a corrosive environment shall be protected against corrosion in an approved manner.

3.6.3 **Ducts serving Type I hoods.** Type I exhaust ducts shall be independent of all other exhaust systems except as provided in Section 3.6.3.5. Commercial kitchen duct systems serving Type I hoods shall be designed, constructed and installed in accordance with Sections 3.6.3.1 through 3.6.3.12.3.

3.6.3.1 **Duct materials.** Ducts serving Type I hoods shall be constructed of materials in accordance with Sections 3.6.3.1.1 and 3.6.3.1.2.

3.6.3.1.1 Grease duct materials. Grease ducts serving Type I hoods shall be constructed of steel not less than 1.5 mm (No. 16 Gage) in thickness or stainless steel not less than 1.0 mm (No. 18 Gage) in thickness.

Exception: Listed and labeled factory-built commercial kitchen grease ducts shall be installed in accordance with Section 3.4.1.

3.6.3.1.2 Makeup air ducts. Make up air ducts connecting to or within 450 mm of a Type I hood shall be constructed and installed in accordance with Sections 4.3.1, 4.3.4, 4.3.5, 4.3.11 and 4.3.14. Duct insulation installed within 450 mm of a Type I hood shall be noncombustible or shall be listed for the application.

3.6.3.2 Joints, seams and penetrations of grease ducts. Joints, seams and penetrations of grease ducts shall be made with a continuous liquid-tight weld or braze made on the external surface of the duct system.

Exceptions:

1. Penetrations shall not be required to be welded or brazed where sealed by devices that are listed for the application.
2. Internal welding or brazing shall not be prohibited provided that the joint is formed or ground smooth and is provided with ready access for inspection.
3. Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 3.4.1.

3.6.3.2.1 Duct joint types. Duct joints shall be butt joints or overlapping duct joints of either the telescoping or bell type. Overlapping joints shall be installed to prevent ledges and obstructions from collecting grease or interfering with gravity drainage to the intended collection point. The difference between the inside cross-sectional dimensions of overlapping sections of duct shall not exceed 5 mm. The length of overlap for overlapping duct joints shall not exceed 50 mm.

3.6.3.2.2 Duct-to-hood joints. Duct-to-hood joints shall be made with continuous internal or external liquid-tight welded or brazed joints. Such joints shall be smooth, accessible for inspection, and without grease traps.

Exceptions: This section shall not apply to:

1. A vertical duct-to-hood collar connection made in the top plane of the hood in accordance with all of the following:
   - 1.1 The hood duct opening shall have a 25 mm deep, full perimeter, welded flange turned down into the hood interior at an angle of 90 degrees from the plane of the opening.
   - 1.2 The duct shall have a 25 mm deep flange made by a 25 mm by 25 mm angle iron welded to the full perimeter of the duct not less than 25 mm above the bottom end of the duct.
   - 1.3 A gasket rated for use at not less than 815°C is installed between the duct flange and the top of the hood.
   - 1.4 The duct-to-hood joint shall be secured by stud bolts not less than 6.5 mm in diameter welded to the hood with a spacing not greater than 100 mm on center for the full perimeter of the opening. All bolts and nuts are to be secured with lock-washers.
2. Listed and labeled duct-to-hood collar connections installed in accordance with Section 3.4.1.

3.6.3.2.3 Duct-to-exhaust fan connections. Duct-to-exhaust fan connections shall be flanged and gasketed at the base of the fan for vertical discharge fans; shall be flanged, gasketed and bolted to the inlet of the fan for side-inlet utility fans; and shall be flanged, gasketed and bolted to the inlet and outlet of the fan for in-line fans.

3.6.3.2.4 Vibration isolation. A vibration isolation connector for connecting a duct to a fan shall consist of noncombustible packing in a metal sleeve joint of approved design or shall be a coated-fabric flexible duct connector listed and labeled for the

application. Vibration isolation connectors shall be installed only at the connection of a duct to a fan inlet or outlet.

3.6.3.3 **Grease duct supports.** Grease duct bracing and supports shall be of noncombustible material securely attached to the structure and designed to carry gravity and seismic loads within the stress limitations of the Saudi Building Code. Bolts, screws, rivets and other mechanical fasteners shall not penetrate duct walls.

3.6.3.4 **Air velocity.** Grease duct systems serving a Type I hood shall be designed and installed to provide an air velocity within the duct system of not less than 7.5 m/s.

Exception: The velocity limitations shall not apply within duct transitions utilized to connect ducts to differently sized or shaped openings in hoods and fans, provided that such transitions do not exceed 900 mm in length and are designed to prevent the trapping of grease.

3.6.3.5 **Separation of grease duct system.** A separate grease duct system shall be provided for each Type I hood. A separate grease duct system is not required where all of the following conditions are met:

1. All interconnected hoods are located within the same story.
2. All interconnected hoods are located within the same room or in adjoining rooms.
3. Interconnecting ducts do not penetrate assemblies required to be fire-resistance rated.
4. The grease duct system does not serve solid fuel-fired appliances.

3.6.3.6 **Grease duct clearances.** Grease duct systems and exhaust equipment serving a Type I hood shall have a clearance to combustible construction of not less than 460 mm, and shall have a clearance to noncombustible construction and gypsum wallboard attached to noncombustible structures of not less than 75 mm.

Exception: Listed and labeled factory-built commercial kitchen grease ducts and exhaust equipment installed in accordance with Section 3.4.1.

3.6.3.7 **Prevention of grease accumulation in grease ducts.** Duct systems serving a Type I hood shall be constructed and installed so that grease cannot collect in any portion thereof and the system shall slope not less than one-fourth unit vertical in 12 units horizontal (2-percent slope) toward the hood or toward an approved grease reservoir. Where horizontal ducts exceed 23 m in length, the slope shall not be less than one unit vertical in 12 units horizontal (8.3-percent slope).

3.6.3.8 **Grease duct cleanouts and other openings.** Grease duct systems shall not have openings therein other than those required for proper operation and maintenance of the system. Any portion of such system having sections not provided with access from the duct entry or discharge shall be provided with cleanout openings. Cleanout openings shall be equipped with tight-fitting doors constructed of steel having a thickness not less than that required for the duct. Doors shall be equipped with a substantial method of latching, sufficient to hold the door tightly closed. Doors shall be designed so that they are operable without the use of a tool. Door assemblies, including any frames and gasketing, shall be approved for the purpose, and shall not have fasteners that penetrate the duct. Listed and labeled access door assemblies shall be installed in accordance with the terms of the listing.

3.6.3.8.1 **Personnel entry.** Where ductwork is large enough to allow entry of personnel, not less than one approved or listed opening having dimensions not less than 500 mm by 500 mm shall be provided in the horizontal sections, and in the top of vertical risers. Where such entry is provided, the duct and its supports shall be capable of supporting the additional load and the cleanouts specified in Section 3.6.3.8 are not required.

3.6.3.9 **Grease duct horizontal cleanouts.** Cleanouts located on horizontal sections of ducts shall be spaced not more than 6.0 m apart. The cleanouts shall be located on the side of the duct with the opening not less than 40 mm above the bottom of the

duct, and not less than 25 mm below the top of the duct. The opening minimum dimensions shall be 300 mm on each side. Where the dimensions of the side of the duct prohibit the cleanout installation prescribed herein, the openings shall be on the top of the duct or the bottom of the duct. Where located on the top of the duct, the opening edges shall be a minimum of 25 mm from the edges of the duct. Where located in the bottom of the duct, cleanout openings shall be designed to provide internal damming around the opening, shall be provided with gasketing to preclude grease leakage, shall provide for drainage of grease down the duct around the dam, and shall be approved for the application. Where the dimensions of the sides, top or bottom of the duct preclude the installation of the prescribed minimum-size cleanout opening, the cleanout shall be located on the duct face that affords the largest opening dimension and shall be installed with the opening edges at the prescribed distances from the duct edges as previously set forth in this section.

3.6.3.10 **Grease duct enclosure.** Grease duct serving a Type I hood that penetrates a ceiling, wall or floor shall be enclosed from the point of penetration to the outlet terminal. Ducts shall penetrate exterior walls only at locations where unprotected openings are permitted by the Saudi Building Code. Ducts shall be enclosed in accordance with the Saudi Building Code requirements for shaft construction. The duct enclosure shall be sealed around the duct at the point of penetration and vented to the outside of the building through the use of weather-protected openings. Clearance from the duct to the interior surface of enclosures of combustible construction shall be not less than 450 mm. Clearance from the duct to the interior surface of enclosures of noncombustible construction or gypsum wallboard attached to noncombustible structures shall be not less than 150 mm. The duct enclosure shall serve a single grease exhaust duct system and shall not contain any other ducts, piping, wiring or systems.

Exceptions:

1. The shaft enclosure provisions of this section shall not be required where a duct penetration is protected with a through-penetration fire stop system classified in accordance with (ASTM E814) and having an “F” and “T” rating equal to the fire-resistance rating of the assembly being penetrated and where the surface of the duct is continuously covered on all sides from the point at which the duct penetrates a ceiling, wall or floor to the outlet terminal with a classified and labeled material, system, method of construction or product specifically evaluated for such purpose, in accordance with a nationally recognized standard for such enclosure materials. Exposed duct wrap systems shall be protected where subject to physical damage.
2. A duct enclosure shall not be required for a grease duct that penetrates only a nonfire-resistance-rated roof/ceiling assembly.

3.6.3.11 **Grease duct fire-resistive access opening.** Where cleanout openings are located in ducts within a fire-resistance-rated enclosure, access openings shall be provided in the enclosure at each cleanout point. Access openings shall be equipped with tight-fitting sliding or hinged doors that are equal in fire-resistive protection to that of the shaft or enclosure. An approved sign shall be placed on access opening panels with wording as follows: “ACCESS PANEL. DO NOT OBSTRUCT”.

3.6.3.12 **Exhaust outlets serving Type I hoods.** Exhaust outlets for grease ducts serving Type I hoods shall conform to the requirements of Sections 3.6.3.12.1 through 3.6.3.12.3.

3.6.3.12.1 **Termination above the roof.** Exhaust outlets that terminate above the roof shall have the discharge opening located not less than 1.0 m above the roof surface.

3.6.3.12.2 **Termination through an exterior wall.** Exhaust outlets shall be permitted to terminate through exterior walls where the smoke, grease, gases, vapors, and odors

in the discharge from such terminations do not create a public nuisance or a fire hazard. Such terminations shall not be located where protected openings are required by the Saudi Building Code. Other exterior openings shall not be located within 900 mm of such terminations.

3.6.3.12.3 **Termination location.** Exhaust outlets shall be located not less than 3.0 m horizontally from parts of the same or contiguous buildings, adjacent property lines and air intake openings into any building and shall be located not less than 3.0 m above the adjoining grade level.

Exception: Exhaust outlets shall terminate not less than 1.5 m from an adjacent building, adjacent property line and air intake openings into a building where air from the exhaust outlet discharges away from such locations.

3.6.4 **Ducts serving Type II hoods.** Single or combined Type II exhaust systems for food-processing operations shall be independent of all other exhaust systems. Commercial kitchen exhaust systems serving Type II hoods shall comply with Sections 3.6.4.1 and 3.6.4.2.

3.6.4.1 **Type II exhaust outlets.** Exhaust outlets for ducts serving Type II hoods shall comply with Sections 2.1.5 and 2.1.5.2. Such outlets shall be protected against local weather conditions and shall meet the provisions for exterior wall opening protective in accordance with the Saudi Building Code.

3.6.4.2 **Ducts.** Ducts and plenums serving Type II hoods shall be constructed of rigid metallic materials. Duct construction, installation, bracing and supports shall comply with Chapter 4. Ducts subject to positive pressure and ducts conveying moisture-laden or waste-heat-laden air shall be constructed, joined and sealed in an approved manner.

3.6.5 **Exhaust equipment.** Exhaust equipment, including fans and grease reservoirs, shall comply with Sections 3.6.5.1 through 3.6.5.5 and shall be of an approved design or shall be listed for the application.

3.6.5.1 **Exhaust fans.** Exhaust fan housings serving a Type I hood shall be constructed as required for grease ducts in accordance with Section 3.6.3.1.1.

3.6.5.1.1 **Fan motor.** Exhaust fan motors shall be located outside of the exhaust air stream.

3.6.5.2 **Exhaust fan discharge.** Exhaust fans shall be positioned so that the discharge will not impinge on the roof, other equipment or appliances or parts of the structure. A vertical discharge fan shall be manufactured with an approved drain outlet at the lowest point of the housing to permit drainage of grease to an approved grease reservoir.

3.6.5.3 **Exhaust fan mounting.** An upblast fan shall be hinged and supplied with a flexible weatherproof electrical cable to permit inspection and cleaning. The ductwork shall extend a minimum of 450 mm above the roof surface.

3.6.5.4 **Clearances.** Exhaust equipment serving a Type I hood shall have a clearance to combustible construction of not less than 450 mm.

Exception: Factory-built exhaust equipment installed in accordance with Section 3.4.1 and listed for a lesser clearance.

3.6.5.5 **Termination location.** The outlet of exhaust equipment serving Type I hoods, shall be in accordance with Section 3.6.3.12.3.

Exception: The minimum horizontal distance between vertical discharge fans and parapet-type building structures shall be 600 mm provided that such structures are not higher than the top of the fan discharge opening.

SECTION 3.7
COMMERCIAL KITCHEN HOODS

3.7.1 **General.** Commercial kitchen exhaust hoods shall comply with the requirements of this section. Hoods shall be Type I or Type II and shall be designed to capture and confine cooking vapors and residues.

Exceptions:

1. Factory-built commercial exhaust hoods which are tested in accordance with (UL 710), listed, labeled and installed in accordance with Section 1.4.1 shall not be required to comply with Sections 3.7.4, 3.7.7, 3.7.11, 3.7.12, 3.7.13, 3.7.14 and 3.7.15.
2. Factory-built commercial cooking recirculating systems which are tested in accordance with (UL 197), listed, labeled and installed in accordance with Section 1.4.1 shall not be required to comply with Sections 3.7.4, 3.7.5, 3.7.7, 3.7.12, 3.7.13, 3.7.14 and 3.7.15.
3. Net exhaust volumes for hoods shall be permitted to be reduced during no-load cooking conditions, where engineered or listed multi-speed or variable-speed controls automatically operate the exhaust system to maintain capture and removal of cooking effluents as required by this section.

3.7.2 **Where required.** A Type I or Type II hood shall be installed at or above all commercial cooking appliances in accordance with Sections 3.7.2.1 and 3.7.2.2. Where any cooking appliance under a single hood requires a Type I hood, a Type I hood shall be installed. Where a Type II hood is required, a Type I or Type II hood shall be installed.

3.7.2.1 **Type I hoods.** Type I hoods shall be installed where cooking appliances produce grease or smoke, such as occurs with griddles, fryers, broilers, ovens, ranges and work ranges.

3.7.2.2 **Type II hoods.** Type II hoods shall be installed where cooking or dishwashing appliances produce heat or steam and do not produce grease or smoke, such as steamers, kettles, pasta cookers and dishwashing machines.

Exceptions:

1. Under-counter-type commercial dishwashing machines.
2. A Type II hood is not required for dishwashers and pot washers that are provided with heat and water vapor exhaust systems that are supplied by the appliance manufacturer and are installed in accordance with the manufacturer's instructions.

3.7.2.3 **Domestic cooking appliances used for commercial purposes.** Domestic cooking appliances utilized for commercial purposes shall be provided with Type I or Type II hoods as required for the type of appliances and processes in accordance with Sections 3.7.2, 3.7.2.1 and 3.7.2.2.

3.7.2.4 **Solid fuel.** Type I hoods for use over solid fuel-burning cooking appliances shall discharge to an exhaust system that is independent of other exhaust systems.

3.7.3 **Fuel-burning appliances.** Where vented fuel-burning appliances are located in the same room or space as the hood, provisions shall be made to prevent the hood system from interfering with normal operation of the appliance vents.

3.7.4 **Type I materials.** Type I hoods shall be constructed of steel not less than 1.1 mm (No. 18 MSG) in thickness, or stainless steel not less than 0.95 mm (No. 20 MSG) in thickness.

3.7.5 **Type II hood materials.** Type II hoods shall be constructed of steel not less than 0.75 mm (No. 22 Gage) in thickness, stainless steel not less than 0.6 mm (No. 24 Gage) in thickness, copper sheets weighing not less than 7.5 kg/m^2, or of other approved material and gage.

3.7.6 **Supports.** Type I hoods shall be secured in place by noncombustible supports. All Type I and Type II hood supports shall be adequate for the applied load of the hood, the unsupported ductwork, the effluent loading, and the possible weight of personnel working in or on the hood.

3.7.7 **Hood joints, seams and penetrations.** Hood joints, seams and penetrations shall comply with Sections 3.7.7.1 and 3.7.7.2.

3.7.7.1 **Type I hoods.** External hood joints, seams and penetrations for Type I hoods shall be made with a continuous external liquid-tight weld or braze to the lowest outermost perimeter of the hood. Internal hood joints, seams, penetrations, filter support frames, and other appendages attached inside the hood shall not be required to be welded or brazed but shall be otherwise sealed to be grease tight.

Exceptions:

1. Penetrations shall not be required to be welded or brazed where sealed by devices that are listed for the application.
2. Internal welding or brazing of seams, joints, and penetrations of the hood shall not be prohibited provided that the joint is formed smooth or ground so as to not trap grease, and is readily cleanable.

3.7.7.2 **Type II hoods.** Joints, seams and penetrations for Type II hoods shall be constructed as set forth in Chapter 4, shall be sealed on the interior of the hood and shall provide a smooth surface that is readily cleanable and water tight.

3.7.8 **Cleaning and grease gutters.** A hood shall be designed to provide for thorough cleaning of the entire hood. Grease gutters shall drain to an approved collection receptacle that is fabricated, designed and installed to allow access for cleaning.

3.7.9 **Clearances for Type I hood.** A Type I hood shall be installed with a clearance to combustibles of not less than 460 mm.

Exception: Clearance shall not be required from gypsum wallboard attached to noncombustible structures provided that a smooth, cleanable, nonabsorbent and noncombustible material is installed between the hood and the gypsum wallboard over an area extending not less than 460 mm in all directions from the hood.

3.7.10 **Hoods penetrating a ceiling.** Type I hoods or portions thereof penetrating a ceiling, wall or furred space shall comply with all the requirements of Section 3.6.3.10.

3.7.11 **Grease filters.** Type I hoods shall be equipped with listed grease filters designed for the specific purpose. Grease-collecting equipment shall be provided with access for cleaning. The lowest edge of a grease filter located above the cooking surface shall be not less than the height specified in Table 3.7.11.

Table 3.7.11
Minimum Distance between the Lowest Edge of a Grease Filter and the Cooking Surface or the Heating Surface

Type of Cooking Appliances	Height Above Cooking Surface (mm)
Without exposed flame	150
Exposed flame and burners	600
Exposed flame and burners	1000

3.7.11.1 **Criteria.** Filters shall be of such size, type and arrangement as will permit the required quantity of air to pass through such units at rates not exceeding those for which the filter or unit was designed or approved. Filter units shall be installed in frames or holders so as to be readily removable without the use of separate tools, unless designed and installed to be cleaned in place and the system is equipped for such cleaning in place. Removable filter units shall be of a size that will allow them to be cleaned in a dishwashing machine or pot sink. Filter units shall be arranged in place or provided with drip-intercepting devices to prevent grease or other condensate from dripping into food or on food preparation surfaces.

3.7.11.2 **Mounting position.** Filters shall be installed at an angle of not less than 45 degrees (0.79 rad) from the horizontal and shall be equipped with a drip tray beneath the lower edge of the filters.

3.7.12 **Canopy size and location.** The inside lower edge of canopy-type commercial cooking hoods shall overhang or extend a horizontal distance of not less than 150 mm beyond the edge of the cooking surface, on all open sides. The vertical distance between the front lower lip of the hood and the cooking surface shall not exceed 1.2 m.

Exception: The hood shall be permitted to be flush with the outer edge of the cooking surface where the hood is closed to the appliance side by a noncombustible wall or panel.

3.7.13 **Capacity of hoods.** Commercial food service hoods shall exhaust a minimum net quantity of air determined in accordance with this section and Sections 3.7.13.1 through 3.7.13.4. The net quantity of exhaust air shall be calculated by subtracting any airflow supplied directly to a hood cavity from the total exhaust flow rate of a hood. Where any combination of extra-heavy-duty, heavy-duty, medium-duty and light-duty cooking appliances are utilized under a single hood, the highest exhaust rate required by this section shall be used for the entire hood.

3.7.13.1 **Extra-heavy-duty cooking appliances.** The minimum net airflow for Type I hoods used for extra-heavy-duty cooking appliances shall be determined as follows:

Type of Hood	L/s per linear meter of hood
Wall-mounted canopy	850
Single island canopy	1100
Double island canopy (per side)	850
Back-shelf/pass-over	Not allowed
Eyebrow	Not allowed

3.7.13.2 Heavy-duty cooking appliances. The minimum net airflow for Type I hoods used for heavy-duty cooking appliances shall be determined as follows:

Type of Hood	L/s per linear meter of hood
Wall-mounted canopy	600
Single island canopy	900
Double island canopy (per side)	600
Back-shelf/pass-over	600
Eyebrow	Not allowed

3.7.13.3 Medium-duty cooking appliances. The minimum net airflow for Type I hoods used for medium-duty cooking appliances shall be determined as follows:

Type of Hood	L/s per linear meter of hood
Wall-mounted canopy	450
Single island canopy	750
Double island canopy (per side)	450
Backshelf/pass-over	450
Eyebrow	400

3.7.13.4 Light-duty cooking appliances. The minimum net airflow for Type I hoods used for light duty cooking appliances and food service preparation and cooking operations approved for use under a Type II hood shall be determined as follows:

Type of Hood	L/s per linear meter of hood
Wall-mounted canopy	300
Single island canopy	600
Double island canopy (per side)	400
Back-shelf/pass-over	400
Eyebrow	400

3.7.14 Noncanopy size and location. Noncanopy-type hoods shall be located a maximum of 900 mm above the cooking surface. The edge of the hood shall be set back a maximum of 300 mm from the edge of the cooking surface.

3.7.15 Exhaust outlets. Exhaust outlets located within the hood shall be located so as to optimize the capture of particulate matter. Each outlet shall serve not more than a 3600 mm section of hood.

3.7.16 Performance test. A performance test shall be conducted upon completion and before final approval of the installation of a ventilation system serving commercial cooking appliances. The test shall verify the rate of exhaust airflow required by Section 3.7.13, makeup airflow required by Section 3.8, and proper operation as specified in this chapter. The permit holder shall furnish the necessary test equipment and devices required to perform the tests.

3.7.16.1 **Capture and containment test.** The permit holder shall verify capture and containment performance of the exhaust system. This field test shall be conducted with all appliances under the hood at operating temperatures. Capture and containment shall be verified visually by observing smoke or steam produced by actual or simulated cooking, such as with smoke candles, smoke puffers, etc.

SECTION 3.8
COMMERCIAL KITCHEN MAKEUP AIR

3.8.1 **Makeup air.** Makeup air shall be supplied during the operation of commercial kitchen exhaust systems that are provided for commercial cooking appliances. The amount of makeup air supplied shall be approximately equal to the amount of exhaust air. The makeup air shall not reduce the effectiveness of the exhaust system. Makeup air shall be provided by gravity or mechanical means or both. For mechanical makeup air systems, the exhaust and makeup air systems shall be electrically interlocked to insure that makeup air is provided whenever the exhaust system is in operation. Makeup air intake opening locations shall comply with Sections 2.1.5 and 2.1.5.1.

3.8.1.1 **Makeup air temperature.** The temperature differential between makeup air and the air in the conditioned space shall not exceed 6^{o}C.

Exceptions:

1. Makeup air that is part of the air-conditioning system.
2. Makeup air that does not decrease the comfort conditions of the occupied space.

3.8.2 **Compensating hoods.** Manufacturers of compensating hoods shall provide a label indicating minimum exhaust flow and/or maximum makeup airflow that provides capture and containment of the exhaust effluent.

SECTION 3.9
FIRE SUPPRESSION SYSTEMS

3.9.1 **Where required.** Commercial food heat-processing appliances required by Section 3.7.2.1 to have a Type I hood shall be provided with an approved automatic fire suppression system complying with the Saudi Building Code and the Saudi Fire Requirements.

SECTION 3.10
HAZARDOUS EXHAUST SYSTEMS

3.10.1 **General.** This section shall govern the design and construction of duct systems for hazardous exhaust and shall determine where such systems are required. Hazardous exhaust systems are systems designed to capture and control hazardous emissions generated from product handling or processes, and convey those emissions to the outdoors. Hazardous emissions include flammable vapors, gases, fumes, mists or dusts, and volatile or airborne materials posing a health hazard, such as toxic or corrosive materials. For the purposes of this section, the health-hazard rating of materials shall be as specified in (NFPA 704).

3.10.2 **Where required.** A hazardous exhaust system shall be required wherever operations involving the handling or processing of hazardous materials, in the absence of such exhaust systems and under normal operating conditions, have the potential to create one of the following conditions:

1. A flammable vapor, gas, fume, mist or dust is present in concentrations exceeding 25 percent of the lower flammability limit of the substance for the expected room temperature.
2. A vapor, gas, fume, mist or dust with a health-hazard rating of 4 is present in any concentration.
3. A vapor, gas, fume, mist or dust with a health-hazard rating of 1, 2 or 3 is present in concentrations exceeding 1 percent of the median lethal concentration of the substance for acute inhalation toxicity.

3.10.2.1 **Lumber yards and woodworking facilities.** Equipment or machinery located inside buildings at lumber yards and woodworking facilities which generates or emits combustible dust shall be provided with an approved dust-collection and exhaust system installed in conformance with this section and the Saudi Fire Requirements. Equipment and systems that are used to collect, process or convey combustible dusts shall be provided with an approved explosion-control system.

3.10.2.2 **Combustible fibers.** Equipment or machinery within a building which generates or emits combustible fibers shall be provided with an approved dust-collecting and exhaust system. Such systems shall comply with these requirements and the Saudi Fire Requirements.

3.10.3 **Design and operation.** The design and operation of the exhaust system shall be such that flammable contaminants are diluted in non-contaminated air to maintain concentrations in the exhaust flow below 25 percent of the contaminant's lower flammability limit.

3.10.4 **Independent system.** Hazardous exhaust systems shall be independent of other types of exhaust systems. Incompatible materials, as defined in the Saudi Fire Requirements, shall not be exhausted through the same hazardous exhaust system. Hazardous exhaust systems shall not share common shafts with other duct systems, except where such systems are hazardous exhaust systems originating in the same fire area. Contaminated air shall not be recirculated to occupied areas unless the contaminants have been removed. Air contaminated with explosive or flammable vapors, fumes or dusts; flammable or toxic gases; or radioactive material shall not be recirculated.

3.10.5 **Design.** Systems for removal of vapors, gases and smoke shall be designed by the constant velocity or equal friction methods. Systems conveying particulate matter shall be designed employing the constant velocity method.

3.10.5.1 **Balancing.** Systems conveying explosive or radioactive materials shall be prebalanced by duct sizing. Other systems shall be balanced by duct sizing with balancing devices, such as dampers. Dampers provided to balance air-flow shall be provided with securely fixed minimum-position blocking devices to prevent restricting flow below the required volume or velocity.

310.5.2 **Emission control.** The design of the system shall be such that the emissions are confined to the area in which they are generated by air currents, hoods or enclosures and shall be exhausted by a duct system to a safe location or treated by removing contaminants.

3.10.5.3 **Hoods required.** Hoods or enclosures shall be used where contaminants originate in a limited area of a space. The design of the hood or enclosure shall be such that air currents created by the exhaust systems will capture the contaminants and transport them directly to the exhaust duct.

3.10.5.4 **Contaminant capture and dilution.** The velocity and circulation of air in work areas shall be such that contaminants are captured by an air stream at the area where the emissions are generated and conveyed into a product-conveying duct

system. Contaminated air from work areas where hazardous contaminants are generated shall be diluted below the thresholds specified in Section 3.10.2 with air that does not contain other hazardous contaminants.

3.10.5.5 **Makeup air.** Makeup air shall be provided at a rate approximately equal to the rate that air is exhausted by the hazardous exhaust system. Makeup air intakes shall be located so as to avoid recirculation of contaminated air.

3.10.5.6 **Clearances.** The minimum clearance between hoods and combustible construction shall be the clearance required by the duct system.

3.10.5.7 **Ducts.** Hazardous exhaust duct systems shall extend directly to the exterior of the building and shall not extend into or through ducts and plenums.

3.10.6 **Penetrations.** Penetrations of structural elements by a hazardous exhaust system shall conform to Sections 3.10.6.1 through 3.10.6.3.

Exception: Duct penetrations within H-5 occupancies as allowed by the Saudi Building Code.

3.10.6.1 **Floors.** Hazardous exhaust systems that penetrate a floor/ceiling as simply shall be enclosed in a fire-resistance-rated shaft constructed in accordance with the Saudi Building Code.

3.10.6.2 **Wall assemblies.** Hazardous exhaust duct systems that penetrate fire-resistance-rated wall assemblies shall be enclosed in fire-resistance-rated construction from the point of penetration to the outlet terminal, except where the interior of the duct is equipped with an approved automatic fire suppression system. Ducts shall be enclosed in accordance with the Saudi Building Code requirements for shaft construction and such enclosure shall have a minimum fire-resistance rating of not less than the highest fire-resistance-rated wall assembly penetrated.

3.10.6.3 **Fire walls.** Ducts shall not penetrate a fire wall.

3.10.7 **Suppression required.** Ducts shall be protected with an approved automatic fire suppression system installed in accordance with the Saudi Building Code.

Exceptions:

1. An approved automatic fire suppression system shall not be required in ducts conveying materials, fumes, mists and vapors that are nonflammable and noncombustible under all conditions and at any concentrations.
2. An approved automatic fire suppression system shall not be required in ducts where the largest cross-sectional diameter of the duct is less than 250 mm.

3.10.8 **Duct construction.** Ducts utilized to convey hazardous exhaust shall be constructed of approved G90 galvanized sheet steel, with a minimum nominal thickness as specified in Table 3.10.8.

Table 3.10.8
Minimum Duct Thickness

	Minimum Nominal Thickness		
Diameter of duct or maximum side dimension	**Nonabrasive materials**	**Nonabrasive/ Abrasive materials**	**Abrasive materials**
0 - 200 mm	0.71 mm (No. 24 Gage)	0.85 mm (No. 22 Gage)	1.0 mm (No. 20 Gage)
225 - 450 mm	0.85 mm (No. 22 Gage)	1.0 mm (No. 20 Gage)	1.3 mm (No. 18 Gage)
475 - 750 mm	1.0 mm (No. 20 Gage)	1.3 mm (No. 18 Gage)	1.6 mm (No. 16 Gage)
Over 750 mm	1.3 mm (No. 18 Gage)	1.6 mm (No. 16 Gage)	2.0 mm (No. 16 Gage)

Nonmetallic ducts utilized in systems exhausting nonflammable corrosive fumes or vapors shall be listed and labeled. Nonmetallic duct shall have a flame spread index of 25 or less and a smoke-developed index of 50 or less, when tested in accordance with (ASTM E 84). Ducts shall be approved for installation in such an exhaust system.

Where the products being exhausted are detrimental to the duct material, the ducts shall be constructed of alternative materials that are compatible with the exhaust.

3.10.8.1 **Duct joints.** Ducts shall be made tight with lap joints having a minimum lap of 25 mm.

3.10.8.2 **Clearance to combustibles.** Ducts shall have a clearance to combustibles in accordance with Table 3.10.8.2. Exhaust gases having temperatures in excess of 320^{o}C shall be exhausted to a chimney in accordance with Section 3.11.2.

Table 3.10.8.2
Clearance to Combustibles

Type of Exhaust or Temperature of Exhaust (°C)	**Clearance to Combustibles** (mm)
Less than 38	25
38 - 315	300
Flammable vapors	150

3.10.8.3 **Explosion relief.** Systems exhausting potentially explosive mixtures shall be protected with an approved explosion relief system or by an approved explosion prevention system designed and installed in accordance with (NFPA 69). An explosion relief system shall be designed to minimize the structural and mechanical damage resulting from an explosion or deflagration within the exhaust system. An explosion prevention system shall be designed to prevent an explosion or deflagration from occurring.

3.10.9 **Supports.** Ducts shall be supported at intervals not exceeding 3.0 meter. Supports shall be constructed of noncombustible material.

SECTION 3.11
DUST, STOCK AND REFUSE CONVEYING SYSTEMS

3.11.1 **Dust, stock and refuse conveying systems.** Dust, stock and refuse conveying systems shall comply with the provisions of Section 3.10 and Sections 3.11.1.1 through 3.11.2.

3.11.1.1 **Collectors and separators.** Cyclone collectors and separators and associated supports shall be constructed of noncombustible materials and shall be located on the exterior of the building or structure. A collector or separator shall not be located nearer than 3.0 m to combustible construction or to an unprotected wall or floor opening, unless the collector is provided with a metal vent pipe that extends above the highest part of any roof within a distance of 9.0 m.

3.11.1.2 **Discharge pipe.** Discharge piping shall conform to the requirements for ducts, including clearances required for high-heat appliances, as contained in these requirements. A delivery pipe from a cyclone collector shall not convey refuse directly into the firebox of a boiler, furnace, dutch oven, refuse burner, incinerator or other appliance.

3.11.1.3 **Conveying system exhaust discharge.** An exhaust system shall discharge to the outside of the building either directly by flue, or indirectly through the separator, bin or vault into which the system discharges.

3.11.1.4 Spark protection. The outlet of an open-air exhaust terminal shall be protected with an approved metal or other noncombustible screen to prevent the entry of sparks.

3.11.1.5 Explosion relief vents. A safety or explosion relief vent shall be provided on all systems that convey combustible refuse or stock of an explosive nature, in accordance with the requirements of the Saudi Building Code.

3.11.1.5.1 Screens. Where a screen is installed in a safety relief vent, the screen shall be attached so as to permit ready release under the explosion pressure.

3.11.1.5.2 Hoods. The relief vent shall be provided with an approved noncombustible cowl or hood, or with a counterbalanced relief valve or cover arranged to prevent the escape of hazardous materials, gases or liquids.

3.11.2 Exhaust outlets. Outlets for exhaust that exceed 315°C shall be designed as a chimney in accordance with Tables 3.11.2.1 and 3.11.2.2.

The termination point for exhaust ducts discharging to the atmosphere shall not be less than the following:

1. Ducts conveying explosive or flammable vapors, fumes or dusts: 9.0 m from property line; 3.0 m from openings into the building; 1.8 m from exterior walls or roofs; 9.0 m from combustible walls or openings into the building which are in the direction of the exhaust discharge; and 3.0 m above adjoining grade.
2. Other product-conveying outlets: 3.0 m from property line; 900 mm from exterior wall or roof; 3.0 m from openings into the building; and 3.0 m above adjoining grade.
3. Environmental air duct exhaust: 900 mm from property line; and 900 mm from openings into the building.

Table 3.11.2.1
Construction Requirements for Single-Wall Metal Chimneys

Chimneys Serving	Minimum Thickness (mm)	
	Walls	Lining
Low-heat appliances (550°C normal operation)	3.2 (No. 10 MSG)	None
Medium-heat appliances (1,100°C maximum)[b]	3.2 (No. 10 MSG)	Up to 450 dia. – 65 Over 450 dia. – 115 on 115 bed
High-heat appliances (Over 1,100°C)[a]	3.2 (No. 10 MSG)	115 laid on 115 bed

Table 3.11.2.2
Clearance and Termination Requirements for Single-Wall Metal Chimneys

Chimneys Serving	Termination				Clearance			
	Above roof opening (m)	Above any part of building within (mm)			Combustible construction (mm)		Non-combustible construction (mm)	
		3	7.5	15	Intr. inst.	Extr. inst.	Intr. inst.	Extr. inst.
Low-heat appliances (550°C normal operation)	0.9	0.6	-	-	450	150	Up to 450 mm diameter, 50	
Medium-heat appliances (1,100°C maximum)[b]	3	-	3	-	900	600	Over 450 mm diameter, 100	
High-heat appliances (Over 1,100°C)[a]	6	-	-	6	See Note c			

a. Lining shall extend from bottom to top of outlet.
b. Lining shall extend from 600 mm below connector to 7300 mm above.
c. Clearance shall be as specified by the design engineer and shall have sufficient clearance from buildings and structures to avoid overheating combustible materials (maximum 71°C).

SECTION 3.12
SUBSLAB SOIL EXHAUST SYSTEMS

3.12.1 **General.** When a subslab soil exhaust system is provided, the duct shall conform to the requirements of this section.

3.12.2 **Materials.** Subslab soil exhaust system duct material shall be air duct material listed and labeled to the requirements of (UL 181) for Class 0 air ducts, or any of the following piping materials that comply with the Saudi Plumbing Requirements as building sanitary drainage and vent pipe: cast iron; galvanized steel; brass or copper pipe; copper tube of a weight not less than that of copper drainage tube, Type DWV; and plastic piping.

3.12.3 **Grade.** Exhaust system ducts shall not be trapped and shall have a minimum slope of one-eighth unit vertical in 12 units horizontal (1-percent slope).

3.12.4 **Termination.** Subslab soil exhaust system ducts shall extend through the roof and terminate at least 150 mm above the roof and at least 3.0 m from any operable openings or air intake.

3.12.5 **Identification.** Subslab soil exhaust ducts shall be permanently identified within each floor level by means of a tag, stencil or other approved marking.

SECTION 3.13
SMOKE CONTROL SYSTEMS

3.13.1 **Scope and purpose.** This section applies to mechanical and passive smoke control systems that are required by the Saudi Building Code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations, or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-venting provisions found in the Saudi Building Code.

3.13.2 **General design requirements.** Buildings, structures, or parts thereof required by these requirements to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of the Saudi Building Code and the generally accepted and well-established principles of engineering relevant to the design. The construction documents shall include sufficient information and detail to describe adequately the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied with sufficient information and analysis to demonstrate compliance with these provisions.

3.13.3 **Special inspection and test requirements.** In addition to the ordinary inspection and test requirements which buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of the Saudi Building Code shall undergo special inspections and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the construction documents shall clearly detail procedures and methods to be used and the items subject to such inspections and

tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published standards for the particular testing involved. The special inspections and tests required by this section shall be conducted under the same terms as found in the Saudi Building Code.

3.13.4 **Analysis.** A rational analysis supporting the types of smoke control systems to be employed, their methods of operation, the systems supporting them, and the methods of construction to be utilized shall accompany the submitted construction documents and shall include, but not be limited to, the items indicated in Sections 3.13.4.1 through 3.13.4.6.

3.13.4.1 **Stack effect.** The system shall be designed such that the maximum probable normal or reverse stack effects will not adversely interfere with the system's capabilities. In determining the maximum probable stack effects, altitude, elevation, weather history and interior temperatures shall be used.

3.13.4.2 **Temperature effect of fire.** Buoyancy and expansion caused by the design fire in accordance with Section 3.13.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with its capabilities.

3.13.4.3 **Wind effect.** The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of the Saudi Building Code.

3.13.4.4 **HVAC systems.** The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems' status. The design shall consider the effects of fire on the HVAC systems.

3.13.4.5 **Climate.** The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

3.13.4.6 **Duration of operation.** All portions of active or passive smoke control systems shall be capable of continued operation after detection of the fire event for not less than 20 minutes.

3.13.5 **Smoke barrier construction.** Smoke barriers shall comply with the Saudi Building Code. Smoke barriers shall be constructed and sealed to limit leakage areas exclusive of protected openings. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls: A/A_w = 0.001
2. Exit enclosures: A/A_w = 0.00035
3. All other shafts: A/A_w = 0.0015
4. Floors and roofs: A/A_F = 0.0005

Where:

A = Total leakage area, m^2.

A_F = Unit floor or roof area of barrier, m^2.

A_w = Unit wall area of barrier, m^2.

The leakage area ratios shown do not include openings due to doors, operable windows or similar gaps. These shall be included in calculating the total leakage area.

3.13.5.1 **Leakage area.** Total leakage area of the barrier is the product of the smoke barrier gross area times the allowable leakage area ratio. Compliance shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems. Passive

smoke control systems tested using other approved means such as door fan testing shall be as approved by the code official.

3.13.5.2 **Opening protection.** Openings in smoke barriers shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by door assemblies complying with the requirements of the Saudi Building Code for doors in smoke barriers.

Exceptions:

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors listed for releasing service installed in accordance with the Saudi Building Code.
2. Fixed openings between smoke zones which are protected utilizing the airflow method.
3. In Group I-2 where such doors are installed across corridors, a pair of opposite-swinging doors without a center mullion shall be installed having vision panels with approved fire-rated glazing materials in approved fire-rated frames, the area of which shall not exceed that tested. The doors shall be close-fitting within operational tolerances, and shall not have undercuts, louvers or grilles. The doors shall have head and jamb stops, astragals or rabbets at meeting edges and automatic-closing devices. Positive latching devices are not required.
4. Group I-3.
5. Openings between smoke zones with clear ceiling heights of 4.2 m or greater and bank down capacity of greater than 20 minutes as determined by the design fire size.

3.13.5.2.1 **Ducts and air transfer openings.** Ducts and air transfer openings are required to be protected with a minimum Class II, 120°C smoke damper complying with the Saudi Building Code.

3.13.6 **Pressurization method.** The primary mechanical means of controlling smoke shall be by pressure differences across smoke barriers. Maintenance of a tenable environment is not required in the smoke control zone of fire origin.

3.13.6.1 **Minimum pressure difference.** The minimum pressure difference across a smoke barrier shall be 12.5 Pa in fully sprinklered buildings. In buildings permitted to be other than fully sprinkle red; the smoke control system shall be designed to achieve pressure differences at least two times the maximum calculated pressure difference produced by the design fire.

3.13.6.2 **Maximum pressure difference.** The maximum air pressure difference across a smoke barrier shall be determined by required door-opening or closing forces. The actual force required to open exit doors when the system is in the smoke control mode shall be in accordance with the Saudi Building Code. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + (WA\Delta P)/2(W-d) \qquad \textbf{(Equation 3-2)}$$

Where:

A = Door area, m^2.
d = Distance from door handle to latch edge of door, m.
F = Total door opening force, N.
F_{dc} = Force required to overcome closing device, N.
W = Door width, m.
ΔP = Design pressure difference, Pa.

3.13.7 **Airflow design method.** When approved by the code official, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflows shall be in accordance with this section. Air-flow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be considered to prevent flow reversal from turbulent effects.

3.13.7.1 **Velocity.** The minimum average velocity through a fixed opening shall not be less than:

$$v = 119.9\,[h\,(T_f - T_o)/T_f]^{1/2} \qquad \textbf{(Equation 3-3)}$$

Where:

h = Height of opening, m.
T_f = Temperature of smoke, ^oK.
T_o = Temperature of ambient air, ^oK.
v = Air velocity, m/minute.

3.13.7.2 **Prohibited conditions.** This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. In no case shall airflow toward the fire exceed 1.0 m/s. Where the formula in Section 3.13.7.1 requires airflow to exceed this limit, the airflow method shall not be used.

3.13.8 **Exhaust method.** When approved by the code official, mechanical smoke control for large enclosed volumes, such as in atria or malls, shall be permitted to utilize the exhaust method. The design exhaust volumes shall be in accordance with this section.

3.13.8.1 **Exhaust rate.** The height of the lowest horizontal surface of the accumulating smoke layer shall be maintained at least 3.0 m above any walking surface which forms a portion of a required egress system within the smoke zone. The required exhaust rate for the zone shall be the largest of the calculated plume mass flow rates for the possible plume configurations. Provisions shall be made for natural or mechanical supply of outside air from outside or adjacent smoke zones to make up for the air exhausted. Makeup airflow rates, when measured at the potential fire location, shall not exceed 1.0 m/s toward the fire. The temperature of the makeup air shall be such that it does not expose temperature-sensitive fire protection systems beyond their limits.

3.13.8.2 **Axisymmetric plumes.** The plume mass flow rate (m_p), in kg/s, shall be determined by placing the design fire center on the axis of the space being analyzed. The limiting flame height shall be determined by:

$$z_l = 0.166\,Q_c^{\,2/5} \qquad \textbf{(Equation 3-4)}$$

Where:

m_p = Plume mass flow rate, kg/s.
Q = Total heat output.
Q_c = Convective heat output, kW.
(The value of Q_c shall not be taken as less than 0.70 Q).
z = Height from top of fuel surface to bottom of smoke layer, m.
z_l = Limiting flame height, m. The z_l value must be greater than the fuel equivalent diameter (see Section 3.13.9).

for $z > z_l$

$$m_p = 0.071\,Q_c^{1/3} z^{5/3} + 0.0018\,Q_c$$

for $z = z_l$

$$m_p = 0.035 Q_c$$

for $z < z_l$

$$m_p = 0.032\,Q_c^{3/5} z$$

To convert m_p from kg per second of mass flow to a volumetric rate, the following formula shall be used:

$$V = m_p / R \qquad \textbf{(Equation 3-5)}$$

Where:

V	=	Volumetric flow-rate, m^3/s.
R	=	Density of air at the temperature of the smoke layer, kg/m^3.

3.13.8.3 Balcony spill plumes. The plume mass flow rate (m_p) for spill plumes shall be determined using the geometrically probable width based on architectural elements and projections in the following formula:

$$m_p = 0.36(Q\,W^2)^{1/3}(z_b + 0.25H) \qquad \textbf{(Equation 3-6)}$$

Where:

H	=	Height above fire to underside of balcony, m.
m_p	=	Plume mass flow rate, kg/s.
Q	=	Total heat output.
W	=	Plume width at point of spill, m.
z_b	=	Height from balcony, m.

3.13.8.4 Window plumes. The plume mass flow rate (m_p) shall be determined from:

$$m_p = 0.68(A_w H_w^{1/2})^{1/3}(z_w + \mathrm{a})^{5/3} + 1.5\,A_w H_w^{1/2} \qquad \textbf{(Equation 3-7)}$$

Where:

A_w	=	Area of the opening, m^2.
H_w	=	Height of the opening, m.
m_p	=	Plume mass flow rate, kg/s.
z_w	=	Height from the top of the window or opening to the bottom of the smoke layer, m.
a	=	$2.4A_w^{2/5}\,H_w^{1/5} - 2.1\,H_w$

3.13.8.5 Plume contact with walls. When a plume contacts one or more of the surrounding walls, the mass flow rate shall be adjusted for the reduced entrainment resulting from the contact provided that the contact remains constant. Use of this provision requires calculation of the plume diameter that shall be calculated by:

$$\mathrm{d} = 0.48\,(T_c/T_a)^{1/2}z \qquad \textbf{(Equation 3-8)}$$

Where:

d	=	Plume diameter, m.
T_a	=	Ambient air température, ^oK.
T_c	=	Plume centerline temperature, ^oK.
	=	$0.08\,T_a\,Q_c^{2/3}\,Z^{-5/3} + T_a$
z	=	Height at which T_c is determined, m.

3.13.9 Design fire. The design fire shall be based on a Q of not less than 5300 kW unless a rational analysis is performed by the registered design professional and approved by the code official. The design fire shall be based on the analysis in accordance with Section 3.13.4 and this section.

3.13.9.1 Factors considered. The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire, and whether the fire is likely to be steady or unsteady.

3.13.9.2 Separation distance. Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration. The ratio of the separation distance to the fuel equivalent radius shall not be less than 4. The fuel equivalent radius shall be the radius of a circle of equal area to floor area of the fuel package. The design fire shall be increased if other combustibles are within the separation distance as determined by:

$$R = [Q/(129\,\pi\,q'')]^{1/2} \qquad \textbf{(Equation 3-9)}$$

Where:

q'' = Incident radiant heat flux required for non-piloted ignition, kW/m^2.
Q = Heat release from fire, kW.
R = Heat release from fire, kW.

3.13.9.3 **Heat-release assumptions.** The analysis shall make use of the best available data from approved sources and shall not be based on excessively stringent limitations of combustible material.

3.13.9.4 **Sprinkler effectiveness assumptions.** A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

3.13.10 **Equipment.** Equipment such as, but not limited to, fans, ducts, automatic dampers and balance dampers shall be suitable for their intended use, suitable for the probable exposure temperatures that the rational analysis indicates, and as approved by the code official.

3.13.10.1 **Exhaust fans.** Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \qquad \textbf{(Equation 3-10)}$$

Where:

c = Specific heat of smoke at smoke-layer temperature, kJ/kg K.
m = Exhaust rate, kg/s.
Q_c = Convective heat output of fire, kW.
T_a = Ambient temperature, K.
T_s = Smoke temperature, K.

Exception: Reduced Ts as calculated based on the assurance of adequate dilution air.

3.13.10.2 **Ducts.** Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 3.13.10.1. Ducts shall be constructed and supported in accordance with Chapter 4. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from fire-resistance-rated structural elements of the building by substantial, noncombustible supports.

Exception: Flexible connections, for the purpose of vibration isolation, that are constructed of approved fire-resistance-rated materials.

3.13.10.3 **Equipment, inlets and outlets.** Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outdoor air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

3.13.10.4 **Automatic dampers.** Automatic dampers, regardless of the purpose for which they are installed within the smoke control system, shall be listed and conform to the requirements of approved recognized standards.

3.13.10.5 **Fans.** In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans

shall be supported and restrained by noncombustible devices in accordance with the structural design requirements of the Saudi Building Code. Motors driving fans shall not be operating beyond their nameplate kilowatts as determined from measurement of actual current draw. Motors driving fans shall have a minimum service factor of 1.15.

3.13.11 **Power systems.** The smoke control system shall be supplied with two sources of power. Primary power shall be the normal building power systems. Secondary power shall be from an approved standby source complying with the Saudi Electrical Requirements. The standby power source and its transfer switches shall be in a separate room from the normal power transformers and switch gear and shall be enclosed in a room constructed of not less than 1-hour fire-resistance-rated fire barriers, ventilated directly to and from the exterior. Power distribution from the two sources shall be by independent routes. Transfer to full standby power shall be automatic and within 60 seconds of failure of the primary power. The systems shall comply with the Saudi Electrical Requirements.

3.13.11.1 **Power sources and power surges.** Elements of the smoke management system relying on volatile memories or the like shall be supplied with uninterruptible power sources of sufficient duration to span 15-minute primary power interruption. Elements of the smoke management system susceptible to power surges shall be suitably protected by conditioners, suppressors or other approved means.

3.13.12 **Detection and control systems.** Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of the Saudi Building Code and (NFPA 72). Such systems shall be equipped with a control unit and listed as smoke control equipment.

Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override, the presence of power downstream of all disconnects and, through a preprogrammed weekly test sequence report, abnormal conditions audibly, visually and by printed report.

3.13.12.1 **Wiring.** In addition to meeting the requirements of the Saudi Electrical Requirements, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

3.13.12.2 **Activation.** Smoke control systems shall be activated in accordance with the Saudi Building Code.

3.13.12.3 **Automatic control.** Where completely automatic control is required or used, the automatic control sequences shall be initiated from an appropriately zoned automatic sprinkler system complying with the Saudi Fire Requirements or from manual controls that are readily accessible to the fire department, and any smoke detectors required by engineering analysis.

3.13.13 **Control-air tubing.** Control-air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections. Tubing shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

3.13.13.1 **Materials.** Control-air tubing shall be hard-drawn copper, Type L, ACR in accordance with (ASTM B 42), (ASTM B 43), (ASTM B 68), (ASTM B 88), (ASTM B 251) and (ASTM B 280). Fittings shall be wrought copper or brass, solder type in accordance with (ASME B16.18) or (ASME B16.22). Changes in

direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solids above 590°C and liquids below 815°C. Brazing flux shall be used on copper-to-brass joints only.

Exception: Nonmetallic tubing used within control panels and at the final connection to devices provided all of the following conditions are met:

1. Tubing shall be listed by an approved agency for flame and smoke characteristics.
2. Tubing and connected device shall be completely enclosed within a galvanized or paint-grade steel enclosure of not less than 0.75 mm thickness. Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or teflon or by suitable brass compression to male barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within the enclosure. Tubing bridging cabinets and doors or moveable devices shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing serving devices on doors shall be fastened along hinges.

3.13.13.2 **Isolation from other functions.** Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

3.13.13.3 **Testing.** Test control-air tubing at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.

3.13.14 **Marking and identification.** The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

3.13.15 **Control diagrams.** Identical control diagrams shall be provided and maintained as required by the Saudi Fire Requirements.

3.13.16 **Fire fighter's smoke control panel.** A fire fighter's smoke control panel for fire department emergency response purposes only shall be provided in accordance with the Saudi Fire Requirements.

3.13.17 **System response time.** Smoke control system activation shall comply with the Saudi Fire Requirements.

3.13.18 **Acceptance testing.** Devices, equipment, components and sequences shall be tested in accordance with the Saudi Fire Requirements.

3.13.19 **System acceptance.** Acceptance of the smoke control system shall be in accordance with the Saudi Fire Requirements.

3.13.20 **Underground building smoke exhaust system.** Where required by the Saudi Building Code for underground buildings, a smoke exhaust system shall be provided in accordance with this section.

3.13.20.1 **Exhaust capability.** Where compartmentation is required, each compartment shall have an independent, automatically activated smoke exhaust system capable of manual operation. The system shall have an air supply and smoke exhaust capability that will provide a minimum of six air changes per hour.

3.13.20.2 **Operation.** The smoke exhaust system shall be operated in accordance with the Saudi Fire Requirements.

3.13.20.3 **Alarm required.** Activation of the smoke exhaust system shall activate an audible alarm at a constantly attended location in accordance with the Saudi Fire Requirements.

SECTION 3.14
ENERGY RECOVERY VENTILATION SYSTEMS

3.14.1 **General.** Energy recovery ventilation systems shall be installed in accordance with this section. Where required for purposes of energy conservation, energy recovery ventilation systems shall also comply with the Saudi Energy Conservation Requirements.

3.14.2 **Prohibited applications.** Energy recovery ventilation systems shall not be used in the following systems:

1. Hazardous exhaust systems covered in Section 3.10.
2. Dust, stock and refuse systems that convey explosive or flammable vapors, fumes or dust.
3. Smoke control systems covered in Section 3.13.
4. Commercial kitchen exhaust systems serving Type-I and Type-II hoods.
5. Clothes dryer exhaust systems covered in Section 3.4.

3.14.3 **Access.** A means of access shall be provided to the heat exchanger and other components of the system as required for service, maintenance, repair or replacement.

CHAPTER 4
DUCT SYSTEMS

SECTION 4.1
GENERAL

4.1.1 **Scope.** Duct systems used for the movement of air in air-conditioning, heating, ventilating and exhaust systems shall conform to the provisions of this chapter except as otherwise specified in Chapters 3 and 5.

Exception: Ducts discharging combustible material directly into any combustion chamber shall conform to the requirements of (NFPA 82).

4.1.2 **Air movement in egress elements.** Exit access corridors shall not serve as supply, return, exhaust, relief or ventilation air ducts.

Exceptions:

1. Use of a corridor as a source of makeup air for exhaust systems in rooms that open directly onto such corridors, including toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor closets, shall be permitted provided that each such corridor is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the corridor.
2. Where located within a dwelling unit, the use of corridors for conveying return air shall not be prohibited.
3. Where located within tenant spaces of 93 m^2 or less in area, utilization of corridors for conveying return air is permitted.

4.1.2.1 **Corridor ceiling.** Use of the space between the corridor ceiling and the floor or roof structure above as a return air plenum is permitted for one or more of the following conditions:

1. The corridor is not required to be of fire-resistance-rated construction;
2. The corridor is separated from the plenum by fire-resistance-rated construction;
3. The air-handling system serving the corridor is shut down upon activation of the air handling unit smoke detectors required by these Requirements;
4. The air-handling system serving the corridor is shut down upon detection of sprinkler water flow where the building is equipped throughout with an automatic sprinkler system; or
5. The space between the corridor ceiling and the floor or roof structure above the corridor is used as a component of an approved engineered smoke control system.

4.1.3 **Contamination prevention.** Exhaust ducts under positive pressure, chimneys, and vents shall not extend into or pass through ducts or plenums.

SECTION 4.2
PLENUMS

4.2.1 **General.** Supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces and mechanical equipment rooms. Plenums shall be limited to one fire area. Fuel-fired appliances shall not be installed within a plenum.

4.2.2 **Construction.** Plenum enclosures shall be constructed of materials permitted for the type of construction classification of the building. The use of gypsum boards to form plenums shall be limited to systems where the air temperatures do not exceed

52°C and the building and mechanical system design conditions are such that the gypsum board surface temperature will be maintained above the air stream dew-point temperature. Air plenums formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers because of high levels of humidity, which result in high dew point.

4.2.2.1 **Materials exposed within plenums.** Except as required by Sections 4.2.2.1.1 through 4.2.2.1.5, materials exposed within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with (ASTM E 84).

Exceptions:

1. Rigid and flexible ducts and connectors shall conform to Section 4.3.
2. Duct coverings, linings, tape and connectors shall conform to Sections 4.3 and 4.4.
3. This section shall not apply to materials exposed within plenums in one- and two-family dwellings.
4. This section shall not apply to smoke detectors.
5. Combustible materials enclosed in approved gypsum board assemblies or enclosed in materials listed and labeled for such application.

4.2.2.1.1 **Wiring.** Combustible electrical or electronic wiring methods and materials, optical fiber cable, and optical fiber raceway exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread not greater than 1.5 m when tested in accordance with (NFPA 262). Only type OFNP (plenum rated nonconductive optical fiber cable) shall be installed in plenum-rated optical fiber raceways. Wiring, cable, and raceways addressed in this section shall be listed and labeled as plenum rated and shall be installed in accordance with *Saudi Electrical Requirements*.

4.2.2.1.2 **Fire sprinkler piping.** Plastic fire sprinkler piping exposed within a plenum shall be used only in wet pipe systems and shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 1.5 m when tested in accordance with (UL 1887). Piping shall be listed and labeled.

4.2.2.1.3 **Pneumatic tubing.** Combustible pneumatic tubing exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 1.5 m when tested in accordance with (UL 1820). Combustible pneumatic tubing shall be listed and labeled.

4.2.2.1.4 **Combustible electrical equipment.** Combustible electrical equipment exposed within a plenum shall have a peak rate of heat release not greater than 100 kilowatts, a peak optical density not greater than 0.50 and an average optical density not greater than 0.15 when tested in accordance with (UL 2043). Combustible electrical equipment shall be listed and labeled.

4.2.2.1.5 **Foam plastic insulation.** Foam plastic insulation used as wall or ceiling finish in plenums shall exhibit a flame spread index of 75 or less and a smoke developed index of 450 or less when tested in accordance with (ASTM E 84) and shall also comply with Section 4.2.2.1.5.1, 4.2.2.1.5.2 or 4.2.2.1.5.3.

4.2.2.1.5.1 **Separation required.** The foam plastic insulation shall be separated from the plenum by a thermal barrier complying with the *Saudi Building Code*.

4.2.2.1.5.2 **Approval.** The foam plastic insulation shall be approved based on tests conducted in accordance with the *Saudi Building Code*.

4.2.2.1.5.3 **Covering.** The foam plastic insulation shall be covered by corrosion resistant steel having base metal thickness of not less than 0.4 mm.

4.2.3 **Flood hazard.** For structures located in flood hazard areas, plenum spaces shall be located above the design flood elevation or shall be designed and constructed to prevent water from entering or accumulating within the plenum spaces during floods up to the design flood elevation. If the plenum spaces are located below the design flood elevation, they shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

SECTION 4.3
DUCT CONSTRUCTION AND INSTALLATION

4.3.1 **General.** An air distribution system shall be designed and installed to supply the required distribution of air. The installation of an air distribution system shall not affect the fire protection requirements specified in the *Saudi Building Code*. Ducts shall be constructed, braced, reinforced and installed to provide structural strength and durability.

4.3.2 **Duct sizing.** Ducts installed within a single dwelling unit shall be sized in accordance with (ACCA Manual D) or other approved methods. Ducts installed within all other buildings shall be sized in accordance with the ASHRAE *Handbook of Fundamentals* or other equivalent computation procedure.

4.3.3 **Duct classification.** Ducts shall be classified based on the maximum operating pressure of the duct at pressures of positive or negative 12.5, 25, 50, 75, 100, 150, or 250 mm of water column. The pressure classification of ducts shall equal or exceed the design pressure of the air distribution in which the ducts are utilized.

4.3.4 **Metallic ducts.** All metallic ducts shall be constructed as specified in the (SMACNA *HVAC Duct Construction Standards — Metal and Flexible*).
Exception: Ducts installed within single dwelling units shall have a minimum thickness as specified in Table 4.3.4.

Table 4.3.4
Duct Construction Minimum Sheet Metal Thicknesses for Single Dwelling Units

Duct Size	Galvanized		Approximate Aluminum B&S Gage
	Minimum Thickness (mm)	Equivalent Galvanized Gage No.	
Round ducts and enclosed rectangular ducts			
350 mm or less	0.33	30	26
Over 350 mm	0.41	28	24
Exposed rectangular ducts			
350 mm or less	0.41	30	24
Over 350 mm	0.48	26	22

4.3.5 **Nonmetallic ducts.** Nonmetallic ducts shall be constructed with Class 0 or Class 1 duct material in accordance with UL 181. Fibrous duct construction shall conform to the (SMACNA *Fibrous Glass Duct Construction Standards*) or (NAIMA *Fibrous Glass Duct Construction Standards*). The maximum air temperature within nonmetallic ducts shall not exceed 120°C.

4.3.5.1 **Gypsum ducts.** The use of gypsum boards to form air shafts (ducts) shall be limited to return air systems where the air temperatures do not exceed 52°C and

the gypsum board surface temperature is maintained above the air stream dew-point temperature. Air ducts formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers because of high air stream dew point.

4.3.6 **Flexible air ducts and flexible air connectors.** Flexible air ducts, both metallic and nonmetallic, shall comply with Sections 4.3.6.1, 4.3.6.1.1, 4.3.6.3 and 4.3.6.4. Flexible air connectors, both metallic and nonmetallic, shall comply with Sections 4.6.6.2 through 4.3.6.4.

4.3.6.1 **Flexible air ducts.** Flexible air ducts, both metallic and nonmetallic, shall be tested in accordance with (UL 181). Such ducts shall be listed and labeled as Class 0 or Class 1 flexible air ducts and shall be installed in accordance with Section 1.4.1.

4.3.6.1.1 **Duct length.** Flexible air ducts shall not be limited in length.

4.3.6.2 **Flexible air connectors.** Flexible air connectors, both metallic and nonmetallic, shall be tested in accordance with (UL 181). Such connectors shall be listed and labeled as Class 0 or Class 1 flexible air connectors and shall be installed in accordance with Section 1.4.1.

4.3.6.2.1 **Connector length.** Flexible air connectors shall be limited in length to 4.3 m measured along its centerline.

4.3.6.2.2 **Connector penetration limitations.** Flexible air connectors shall not pass through any wall, floor or ceiling.

4.3.6.2.3 **Flexible air connector installation.** Flexible air connectors in addition to the requirements of 4.3.6.2.2 above shall be installed so that no bends are greater than 45^o. Crimping or sagging of flexible air connector by more than 50 mm measured from the center line of the flexible connector is not allowed.

4.3.6.3 **Air temperature.** The design temperature of air to be conveyed in flexible air ducts and flexible air connectors shall be less than 120^oC.

4.3.6.4 **Flexible air duct and air connector clearance**. Flexible air ducts and air connectors shall be installed with a minimum clearance to an appliance as specified in the appliance manufacturer's installation instructions.

4.3.7 **Rigid duct penetrations.** Duct system penetrations of walls, floors, ceilings and roofs and air transfer openings in such building components shall be protected as required by Section 4.7.

4.3.8 **Underground ducts.** Ducts shall be approved for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 50 mm of concrete.

4.3.8.1 **Slope.** Ducts shall slope to allow drainage to a point provided with access.

4.3.8.2 **Sealing.** Ducts shall be sealed and secured prior to pouring the concrete encasement.

4.3.8.3 **Plastic ducts and fittings.** Plastic ducts shall be constructed of PVC having a minimum pipe stiffness of 55 kPa at 5-percent deflection when tested in accordance with (ASTM D2412). Plastic duct fittings shall be constructed of either PVC or high-density polyethylene. Plastic duct and fittings shall be utilized in underground installations only. The maximum design temperature for systems utilizing plastic duct and fittings shall be 65^oC.

4.3.9 **Joints, seams and connections.** All longitudinal and transverse joints, seams and connections in metallic and nonmetallic ducts shall be constructed as specified in (SMACNA HVAC *Duct Construction Standards—Metal and Flexible*) and (SMACNA *Fibrous Glass Duct Construction Standards*) or (NAIMA *Fibrous*

Glass Duct Construction Standards). All longitudinal and transverse joints, seams and connections shall be sealed in accordance with the *Saudi Building Code Energy Conservation Requirements*.

4.3.10 Supports. Ducts shall be supported with approved hangers at intervals not exceeding 3 m or by other approved duct support systems designed in accordance with the *Saudi Building Code*. Flexible and other factory-made ducts shall be supported in accordance with the manufacturer's installation instructions.

4.3.11 Condensation. Provisions shall be made to prevent the formation of condensation on the exterior of any duct.

4.3.12 Flood hazard areas. For structures in flood hazard areas, ducts shall be located above the design flood elevation or shall be designed and constructed to prevent water from entering or accumulating within the ducts during floods up to the design flood elevation. If the ducts are located below the design flood elevation, the ducts shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

4.3.13 Location. Ducts shall not be installed in or within 100 mm of the earth, except where such ducts comply with Section 4.3.7.

4.3.14 Mechanical protection. Ducts installed in locations where they are exposed to mechanical damage by vehicles or from other causes shall be protected by approved barriers.

4.3.15 Weather protection. All ducts including linings, coverings and vibration isolation connectors installed on the exterior of the building shall be adequately protected against the elements.

4.3.16 Registers, grilles and diffusers. Duct registers, grilles and diffusers shall be installed in accordance with the manufacturer's installation instructions. Duct-registers, grilles and diffusers shall not be installed directly on to main ducts in general. However this may be allowed in large shopping malls, substations, workshops, warehouses and other high ceiling and public areas where noise is not a problem.

4.3.16.1 Floor registers. Floor registers shall resist, without structural failure, a 90 kg concentrated load on a 50 mm–diameter disc applied to the most critical area of the exposed face.

4.3.16.2 Slot type, grilles and diffusers location. Perimeter slot diffusers or similar shall not be located on the same duct branch with standard type diffusers except when using necessary dampers for proper balancing.

4.3.17 Balancing volume dampers. Each supply or return branch duct serving a separate zone or room shall have a balancing volume damper.

4.3.17.1 Balancing volume damper installation. Balancing volume dampers shall be located a minimum of two duct sizes away from fittings and in compliance to manufacture's requirements.

SECTION 4.4
INSULATION

4.4.1 **General.** Duct insulation shall conform to the requirements of Sections 4.4.2 through 4.4.13 and the *Saudi Energy Conservation Requirements*.

4.4.2 **Surface temperature.** Ducts that operate at temperatures exceeding 49°C shall have sufficient thermal insulation to limit the exposed surface temperature to 49°C.

4.4.3 **Coverings and linings.** Coverings and linings, including adhesives when used, shall have a flame spread index not more than 25 and a smoke-developed index not more than 50, when tested in accordance with (ASTM E 84). Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with (ASTM C 411) at the temperature to which they are exposed in service. The test temperature shall not fall below 120°C.

4.4.4 **Foam plastic insulation.** Foam plastic used as duct coverings and linings shall conform to the requirements of Section 4.4.

4.4.5 **Appliance insulation.** Listed and labeled appliances that are internally insulated shall be considered as conforming to the requirements of Section 4.4.

4.4.6 **Penetration of assemblies.** Duct coverings shall not penetrate a wall or floor required to have a fire-resistance rating or required to be fire blocked.

4.4.7 **Identification.** External duct insulation and factory-insulated flexible duct shall be legibly printed or identified at intervals not greater than 0.9 m with the name of the manufacturer, the thermal resistance *R*-value at the specified installed thickness and the flame spread and smoke-developed indexes of the composite materials. All duct insulation product *R*-values shall be based on insulation only, excluding air films, vapor-retarders or other duct components, and shall be based on tested *C*-values (thermal conductivity) at 24°C mean temperature at the installed thickness, in accordance with recognized industry procedures. The installed thickness of duct insulation used to determine its *R*-values shall be determined as follows:

1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.
3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

4.4.8 **Lining installation.** Linings shall be interrupted at the area of operation of a fire damper and at a minimum of 150 mm upstream of and 150 mm downstream of electric-resistance in a duct system. Metal nosings or sleeves shall be installed over exposed duct liner edges that face opposite the direction of airflow for protecting the liner.

4.4.9 **Thermal continuity.** Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

4.4.10 **Service openings.** Service openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

4.4.11 **Vapor retarders.** Where ducts used for cooling are externally insulated, the insulation shall be covered with a vapor retarder having a maximum permeance of 2.87 ng/(Pa·s·m^2) or aluminum foil having a minimum thickness of 0.05 mm. Insulations having a permeance of 2.87 ng/(Pa·s·m^2) or less shall not be required to be covered. All joints and seams shall be sealed to maintain the continuity of the vapor retarder.

4.4.12 **Weatherproof barriers.** Insulated exterior ducts installed outdoors shall be protected from moisture and sunlight degradation via an approved weatherproof barrier.

4.4.13 **Internal duct lining insulation.** Internal duct lining insulation shall not be used except in acoustically sensitive areas. Materials used as internal insulation and exposed to the air stream in ducts shall be shown to be durable when tested in accordance with (UL 181). Exposed internal insulation that is not impermeable to water shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.
Exception: Approved internal lining that incorporates an approved protective coating to prevent erosion and moisture absorption is permitted for terminal boxes and air-handling units.

SECTION 4.5
AIR FILTERS

4.5.1 **General.** Heating and air-conditioning systems of the central type shall be provided with approved air filters. Filters shall be installed in the return air system, upstream from any heat exchanger or coil, in an approved convenient location. Liquid adhesive coatings used on filters shall have a flash point not lower than 163^{o}C.

4.5.2 **Approval.** Media-type and electrostatic-type air filters shall be listed and labeled. Media-type air filters shall comply with (UL 900). High efficiency particulate air filters shall comply with (UL 586). Electrostatic-type air filters shall comply with (UL 867). Air filters utilized within dwelling units shall be designed for the intended application and shall not be required to be listed and labeled.

4.5.3 **Air filter efficiency.** Efficiency of air filters shall meet, as a minimum, the requirements listed in ASHRAE Applications and ASHRAE Systems and Equipment Handbooks, latest editions.

4.5.4 **Airflow over the filter.** Ducts shall be constructed to allow an even distribution of air over the entire filter.

4.5.5 **Airflow velocity over filter.** Air velocity over filters shall not exceed 3 m/s.

4.5.6 **Air filters for built-up HVAC systems.** Built-up HVAC systems shall be provided with a pre-filter section and a final-filter section.

4.5.7 **Air filters for packaged or residential HVAC systems.** Air filters for packaged or residential HVAC systems shall be replaceable media or washable material with a minimum 70 % weight arrestance rating.

4.5.8 **Sand trap filter.** For HVAC systems having outside air equal to or greater than 30 % of total supply air or having an outside air flow rate of 2400 l/s or greater an approved sand trap filter shall be provided and located ahead of all ductwork. Additionally sand trap filters shall be located to minimize solid particles intrusion such that the bottom of the sand trap filter shall be installed not less than 3 m above finished ground level. This is in addition to the requirements of section 2.1.5 of these requirements.

Exception: Not applicable to residential applications.

SECTION 4.6
SMOKE DETECTION SYSTEMS CONTROL

4.6.1 **Controls required.** Air distribution systems shall be equipped with smoke detectors listed and labeled for installation in air distribution systems, as required by this section.

4.6.2 **Where required.** Smoke detectors shall be installed where indicated in Sections 4.6.2.1 through 4.6.2.3.

Exception: Smoke detectors shall not be required where air distribution systems are incapable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.

4.6.2.1 **Return air systems.** Smoke detectors shall be installed in return air systems with a design capacity greater than 0.9 m^3/s, in the return air duct or plenum upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment and appliances.

Exception: Smoke detectors are not required in the return air system where all portions of the building served by the air distribution system are protected by area smoke detectors connected to a fire alarm system in accordance with the Saudi Fire Requirements. The area smoke detection system shall comply with Section 4.6.4.

4.6.2.2 **Common supply and return air systems.** Where multiple air-handling systems share common supply or return air ducts or plenums with a combined design capacity greater than 0.9 m^3/s, the return air system shall be provided with smoke detectors in accordance with Section 4.6.2.1.

Exception: Individual smoke detectors shall not be required for each fan-powered terminal unit, provided that such units do not have an individual design capacity greater than 0.9 m^3/s and will be shutdown by activation of one of the following:

1. Smoke detectors required by Sections 4.6.2.1 and 4.6.2.3.
2. An approved area smoke detector system located in the return air plenum serving such units.
3. An area smoke detector system as prescribed in the exception to Section 4.6.2.1. In all cases, the smoke detectors shall comply with Sections 4.6.4 and 4.6.4.1.

4.6.2.3 **Return air risers.** Where return air risers serve two or more stories and serve any portion of a return air system having a design capacity greater than 7 m^3/s, smoke detectors shall be installed at each story. Such smoke detectors shall be located upstream of the connection between the return air riser and any air ducts or plenums.

4.6.3 **Installation.** Smoke detectors required by this section shall be installed in accordance with (NFPA 72). The required smoke detectors shall be installed to monitor the entire airflow conveyed by the system including return air and exhaust

or relief air. Access shall be provided to smoke detectors for inspection and maintenance.

4.6.4 **Controls operation.** Upon activation, the smoke detectors shall shut down the air distribution system. Air distribution systems that are part of a smoke control system shall switch to the smoke control mode upon activation of a detector.

4.6.4.1 **Supervision.** The duct smoke detectors shall be connected to a fire alarm system. The actuation of a duct smoke detector shall activate a visible and audible supervisory signal at a constantly attended location.

Exceptions:

1. The supervisory signal at a constantly attended location is not required where the duct smoke detector activates the building's alarm-indicating appliances.
2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an approved location. Duct smoke detector trouble conditions shall activate a visible or audible signal in an approved location and shall be identified as air duct detector trouble.

SECTION 4.7
DUCTS AND AIR TRANSFER OPENINGS

4.7.1 **General.** The provisions of this section shall govern the protection of duct penetrations and air transfer openings in fire-resistance-rated assemblies.

4.7.1.1 **Ducts and air transfer openings without dampers.** Ducts and air transfer openings that penetrate fire-resistance-rated assemblies and are not required to have dampers by this section shall comply with the requirements of the *Saudi Building Code*.

4.7.2 **Installation.** Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling dampers located within air distribution and smoke control systems shall be installed in accordance with the requirements of this section, and the manufacturer's installation instructions and listing.

4.7.2.1 **Smoke control system.** Where the installation of a fire damper will interfere with the operation of a required smoke control system in accordance with Section 3.13, approved alternative protection shall be utilized.

4.7.2.2 **Hazardous exhaust ducts.** Fire dampers for hazardous exhaust duct systems shall comply with Section 3.10.

4.7.2.3 **Fire damper installation.** Fire dampers shall be securely mounted in fire rated separation wall, ceiling or floor such that the associated ductwork can breakaway without lessening the fire separation rating.

4.7.3 **Damper testing and ratings.** Dampers shall be listed and bear the label of an approved testing agency indicating compliance with the standards in this section. Fire dampers shall comply with the requirements of (UL 555). Only fire dampers labeled for use in dynamic systems shall be installed in heating, ventilation and air-conditioning systems designed to operate with fans on during a fire. Smoke dampers shall comply with the requirements of (UL 555S). Combination fire/smoke dampers shall comply with the requirements of both (UL 555) and (UL 555S). Ceiling radiation dampers shall comply with the requirements of (UL 555C).

4.7.3.1 **Fire protection rating.** Fire dampers shall have the minimum fire protection rating specified in Table 4.7.3.1 for the type of penetration.

Table 4.7.3.1
Fire Damper Rating

Type of Penetration	Minimum Damper Rating (hour)
Less than 3-hour fire-resistance-rated assemblies	1.5
3-hour or greater fire-resistance-rated assemblies	3

4.7.3.1.1 **Fire damper actuating device.** The fire damper actuating device shall meet one of the following requirements:

1. The operating temperature shall be approximately 28°C above the normal temperature within the duct system, but not less than 70°C.
2. The operating temperature shall be not more than 140°C where located in a smoke control system complying with Section 3.13.
3. Where a combination fire/smoke damper is located in a smoke control system complying with Section 3.13, the operating temperature rating shall be approximately 28°C above the maximum smoke control system designed operating temperature, or a maximum temperature of 177°C. The temperature shall not exceed the (UL 555S) degradation test temperature rating for a combination fire/smoke damper.

4.7.3.2 **Smoke damper ratings.** Smoke damper leakage ratings shall not be less than Class II. Elevated temperature ratings shall be not less than 120°C.

4.7.3.2.1 **Smoke damper actuation methods.** The smoke damper shall close upon actuation of a listed smoke detector or detectors installed in accordance with Section 4.7 of these requirements and with the *Saudi Building Code* and one of the following methods, as applicable:

1. Where a damper is installed within a duct, a smoke detector shall be installed in the duct within 1.5 m of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.
2. Where a damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.
3. Where a damper is installed within an unducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 1.5 m horizontally of the damper.
4. Where a damper is installed in a corridor wall, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.
5. Where a total-coverage smoke detector system is provided within areas served by an HVAC system, dampers shall be permitted to be controlled by the smoke detection system.

4.7.4 **Access and identification.** Fire and smoke dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance of the damper and its operating parts. The access shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the fire-resistance rating of the assembly. Access points shall be permanently identified on the exterior by a label having letters not less than 12.5 mm in height reading: SMOKE DAMPER or FIRE DAMPER. Access doors in ducts shall be tight fitting and suitable for the required duct construction.

4.7.5 **Where required.** Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling radiation dampers shall be provided at the locations prescribed in this section. Where an assembly is required to have both fire dampers and smoke dampers, combination fire/smoke dampers or a fire damper and a smoke damper shall be required.

4.7.5.1 **Firewalls.** Ducts and air transfer openings permitted in firewalls in accordance with *Saudi Building Code* shall be protected with approved fire dampers installed in accordance with their listing.

4.7.5.2 **Fire barriers.** Duct penetrations and air transfer openings in fire barriers shall be protected with approved fire dampers installed in accordance with their listing.

Exceptions: Fire dampers are not required at penetrations of fire barriers where any of the following apply:

1. Penetrations are tested in accordance with (ASTM E 119) as part of the fire-resistance-rated assembly.
2. Ducts are used as part of an approved smoke control system in accordance with Section 3.13.
3. Such walls are penetrated by ducted HVAC systems, have a required fire-resistance rating of 1 hour or less, are in areas of other than Group H and are in buildings equipped throughout with an automatic sprinkler system in accordance with the *Saudi Building Code*. For the purposes of this exception, a ducted HVAC system shall be a duct system for the structure's HVAC system. Such a duct system shall be constructed of sheet metal not less than 0.55 mm (26-gage) thickness and shall be continuous from the air-handling appliance or equipment to the air outlet and inlet terminals.

4.7.5.3 **Fire partitions.** Duct penetrations in fire partitions shall be protected with approved fire dampers installed in accordance with their listing.

Exceptions: In occupancies other than Group H, fire dampers are not required where any of the following apply:

1. The partitions are tenant separation and corridor walls in buildings equipped throughout with an automatic sprinkler system in accordance with the *Saudi Building Code* and the duct is protected as a through penetration in accordance with the *Saudi Building Code*.
2. The duct system is constructed of approved materials in accordance with these requirements and the duct penetrating the wall meets all of the following minimum requirements:
   - 2.1 The duct section shall not exceed 0.06 m^2.
   - 2.2 The duct shall be constructed of steel with a minimum of 0.55 mm in thickness.
   - 2.3 The duct shall not have openings that communicate the corridor with adjacent spaces or rooms.
   - 2.4 The duct shall be installed above a ceiling.
   - 2.5 The duct shall not terminate at a wall register in the fire-resistance-rated wall.
   - 2.6 A minimum 300 mm long by 0.5 mm thick steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 38 mm by 38 mm by 1.5 mm steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 (M5) screws. The annular space between the steel sleeve and the wall opening shall be filled with rock (mineral) wool batting on all sides.

4.7.5.4 **Corridors/Smoke barriers.** A listed smoke damper designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a smoke barrier wall or a corridor wall required to have smoke and draft control

doors in accordance with the *Saudi Building Code*. Smoke dampers and smoke damper actuation methods shall comply with Section 4.7.5.4.1.

Exceptions:

1. Smoke dampers are not required in corridor penetrations where the building is equipped throughout with an approved smoke control system in accordance with Section 3.13 and smoke dampers are not necessary for the operation and control of the system.
2. Smoke dampers are not required in smoke barrier penetrations where the openings in ducts are limited to a single smoke compartment and the ducts are constructed of steel.
3. Smoke dampers are not required in corridor penetrations where the duct is constructed of steel not less than 0.5 mm in thickness and there are no openings serving the corridor.

4.7.5.4.1 **Smoke damper.** The smoke damper shall close upon actuation of a listed smoke detector or detectors installed in accordance with the *Saudi Building Code* and one of the following methods, as applicable:

1. Where a damper is installed within a duct, a smoke detector shall be installed in the duct within 1.5 m of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed.
2. Where a damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.
3. Where a damper is installed within an unducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 1.5 m horizontally of the damper.
4. Where a damper is installed in a corridor wall, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.
5. Where a total-coverage smoke detector system is provided within all areas served by an HVAC system, dampers shall be permitted to be controlled by the smoke detection system.

4.7.5.5 **Shaft enclosures.** Ducts and air transfer openings shall not penetrate a shaft serving as an exit enclosure except as permitted by the *Saudi Building Code*.

4.7.5.5.1 **Penetrations of shaft enclosures.** Shaft enclosures that are permitted to be penetrated by ducts and air transfer openings shall be protected with approved fire and smoke dampers installed in accordance with their listing.

Exceptions:

1. Fire dampers are not required at penetrations of shafts where:
   - 1.1 Steel exhaust sub-ducts extend at least 560 mm vertically in exhaust shafts provided there is a continuous airflow upward to the outside, or
   - 1.2 Penetrations are tested in accordance with (ASTM E 119) as part of the fire-resistance-rated assembly, or
   - 1.3 Ducts are used as part of an approved smoke control system designed and installed in accordance with the *Saudi Building Code,* and where the fire damper will interfere with the operation of the smoke control system, or
   - 1.4 The penetrations are in parking garage exhaust or supply shafts that are separated from other building shafts by not less than 2-hour fire-resistance-rated construction.
2. In Group B occupancies, equipped throughout with an automatic sprinkler system in accordance with the *Saudi Building Code*, smoke dampers are not required at penetrations of shafts where:

2.1 Bathroom and toilet room exhaust openings with steel exhaust subducts, having a wall thickness of at least 0.5 mm extend at least 560 mm vertically and the exhaust fan at the upper terminus is powered continuously in accordance with the provisions of the *Saudi Building Code*, and maintains airflow upward to the outside, or

2.2 Ducts are used as part of an approved smoke control system designed and installed in accordance with the *Saudi Building Code*, and where the smoke damper will interfere with the operation of the smoke control system.

3. Smoke dampers are not required at penetration of exhaust or supply shafts in parking garages that are separated from other building shafts by not less than 2-hour fire-resistance-rated construction.

4.7.6 **Horizontal assemblies.** Penetrations by air ducts of a floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly shall be protected by a shaft enclosure that complies with the *Saudi Building Code* or shall comply with this section.

4.7.6.1 **Through penetrations**. In occupancies other than Groups I-2 and I-3, a duct and air transfer opening system constructed of approved materials in accordance with these requirements that penetrates a fire-resistance-rated floor/ceiling assembly that connects not more than two stories is permitted without shaft enclosure protection provided a fire damper is installed at the floor line.

Exception: A duct is permitted to penetrate three floors or less without a fire damper at each floor provided it meets all of the following requirements:

1. The duct shall be contained and located within the cavity of a wall and shall be constructed of steel not less than 0.5 mm (26 gauge) in thickness.

2. The duct shall open into only one dwelling unit or sleeping unit and the duct system shall be continuous from the unit to the exterior of the building.

3. The duct shall not exceed 100 mm nominal diameter and the total area of such ducts shall not exceed 645 cm^2 for any 9.3 m^2 of the floor area.

4. The annular space around the duct is protected with materials that prevent the passage of flame and hot gases sufficient to ignite cotton waste where subjected to (ASTM E 119) time-temperature conditions under a minimum positive pressure differential of 2.5 Pa at the location of the penetration for the time period equivalent to the fire-resistance rating of the construction penetrated.

5. Grille openings located in a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with a ceiling radiation damper in accordance with Section 4.7.6.2.

4.7.6.2 **Membrane penetrations.** Where duct systems constructed of approved materials in accordance with these requirements penetrate a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly, shaft enclosure protection is not required provided an approved ceiling radiation damper is installed at the ceiling line. Where a duct is not attached to a diffuser that penetrates a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly, shaft enclosure protection is not required provided an approved ceiling radiation damper is installed at the ceiling line. Ceiling radiation dampers shall be installed in accordance with (UL 555C) and constructed in accordance with the details listed in a fire-resistance-rated assembly or shall be labeled to function as a heat barrier for air-handling outlet/inlet penetrations in the ceiling of a fire-resistance-rated assembly. Ceiling radiation dampers shall not be required where (ASTM E 119) fire tests have shown that ceiling radiation dampers are not necessary in order to maintain the fire-resistance rating of the assembly.

4.7.6.3 **Non-fire-resistance-rated assemblies.** Duct systems constructed of approved materials in accordance with these requirements that penetrate non-fire-resistance-rated floor assemblies that connect not more than two stories are permitted without shaft enclosure protection provided that the annular space between the assembly and the penetrating duct is filled with an approved noncombustible material to resist the free passage of flame and the products of combustion. Duct systems constructed of approved materials in accordance with these requirements that penetrate non-rated floor assemblies that connect not more than three stories are permitted without shaft enclosure protection provided that the annular space between the assembly and the penetrating duct is filled with an approved noncombustible material to resist the free passage of flame and the products of combustion, and a fire damper is installed at each floor line.

Exception: Fire dampers are not required in ducts within individual residential dwelling units.

4.7.7 **Flexible ducts and air connectors**. Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly.

CHAPTER 5
COMBUSTION AIR

SECTION 5.1
GENERAL

5.1.1 **Scope.** The provisions of this chapter shall govern the requirements for combustion and dilution air for fuel-burning appliances other than gas-fired appliances. The requirements for combustion and dilution air for gas-fired appliances shall be in accordance with the *Saudi Building Code Fuel Gas Requirements*.

5.1.2 **Combustion and dilution air required.** Every room or space containing fuel-burning appliances shall be provided with combustion and dilution air as required by these requirements. Combustion and dilution air shall be provided in accordance with Section 5.2, 5.3, 5.4, 5.5, 5.6 or 5.7 or shall be provided by an approved engineered system. Direct vent appliances or equipment that do not draw combustion air from inside of the building are not required to be considered in the determination of the combustion and dilution air requirements. Combustion air requirements shall be determined based on the simultaneous operation of all fuel-burning appliances drawing combustion and dilution air from the room or space.

5.1.3 **Circulation of air.** The equipment and appliances within every room containing fuel-burning appliances shall be installed so as to allow free circulation of air. Provisions shall be made to allow for the simultaneous operation of mechanical exhaust systems, fireplaces or other equipment and appliances operating in the same room or space from which combustion and dilution air is being drawn. Such provisions shall prevent the operation of such appliances, equipment and systems from affecting the supply of combustion and dilution air.

5.1.4 **Crawl space and attic space.** For the purposes of this chapter, an opening to a naturally ventilated crawl space or attic space shall be considered equivalent to an opening to the outdoors.

5.1.4.1 **Crawl space.** Where lower combustion air openings connect with crawl spaces, such spaces shall have unobstructed openings to the outdoors at least twice that required for the combustion air openings. The height of the crawl space shall comply with the requirements of the *Saudi Building Code* and shall be without obstruction to the free flow of air.

5.1.4.2 **Attic space.** Where combustion air is obtained from an attic area, the attic ventilating openings shall not be subject to ice or snow blockage, and the attic shall have not less than 750 mm vertical clear height at its maximum point. Attic ventilation openings shall be sufficient to provide the required volume of combustion air and the attic ventilation required by the *Saudi Building Code*. The combustion air openings shall be provided with a sleeve of not less than 0.5 mm (No. 26 Gage) galvanized steel or other approved material extending from the appliance enclosure to at least 150 mm above the top of the ceiling joists and insulation.

5.1.5 **Prohibited sources.** Openings and ducts shall not connect appliance enclosures with a space in which the operation of a fan will adversely affect the flow of the combustion air. Combustion air shall not be obtained from a hazardous location, except where the fuel-fired appliances are located within the hazardous location and are installed in accordance with these requirements. Combustion air shall not

be taken from a refrigeration machinery room, except where a refrigerant vapor detector system is installed to automatically shutoff the combustion process in the event of refrigerant leakage. Combustion air shall not be obtained from any location below the design flood elevation.

SECTION 5.2
INSIDE AIR

5.2.1 **All air from indoors.** Combustion and dilution air shall be permitted to be obtained entirely from the indoors in buildings that are not of unusually tight construction. In buildings of unusually tight construction, combustion air shall be obtained from the outdoors in accordance with Section 5.3, 5.5, 5.6 or 5.7.

5.2.2 **Air from the same room or space.** The room or space containing fuel-burning appliances shall be an unconfined space as defined in Section 2.2.

5.2.3 **Air from adjacent spaces.** Where the volume of the room in which the fuel-burning appliances are located does not comply with Section 5.2.2, additional inside combustion and dilution air shall be obtained by opening the room to adjacent spaces so that the combined volume of all communicating spaces meets the volumetric requirements of Section 5.2.2. Openings connecting the spaces shall comply with Sections 5.2.3.1 and 5.2.3.2.

5.2.3.1 **Number and location of openings.** Two openings shall be provided, one within 300 mm from the ceiling of the room and one within 300 mm from the floor.

5.2.3.2 **Size of openings.** The net free area of each opening, calculated in accordance with Section 5.8, shall be a minimum of 2200 mm^2/kW of input rating of the fuel-burning appliances drawing combustion and dilution air from the communicating spaces and shall be not less than 64000 mm^2.

SECTION 5.3
OUTDOOR AIR

5.3.1 **All air from the outdoors.** Where all combustion and dilution air is to be provided by outdoor air, the required combustion and dilution air shall be obtained by opening the room to the outdoors. Openings connecting the room to the outdoor air shall comply with Sections 5.3.1.1 through 5.3.1.4.

5.3.1.1 **Number and location of openings.** Two openings shall be provided, one within 300 mm from the ceiling of the room and one within 300 mm from the floor.

5.3.1.2 **Size of direct openings.** The net free area of each direct opening to the outdoors, calculated in accordance with Section 5.9, shall be a minimum of 550 mm^2/kW of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room.

5.3.1.3 **Size of horizontal openings.** The net free area of each opening, calculated in accordance with Section 5.9 and connected to the outdoors through a horizontal duct, shall be a minimum of 1100 mm^2/kW of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room. The cross-sectional area of the duct shall be equal to or greater than the required size of the opening.

5.3.1.4 **Size of vertical openings.** The net free area of each opening, calculated in accordance with Section 5.9 and connected to the outdoors through a vertical duct, shall be a minimum of 550 mm^2/kW of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room. The cross-

sectional area of the duct shall be equal to or greater than the required size of the opening.

SECTION 5.4
COMBINED USE OF INSIDE AND OUTDOOR AIR (CONDITION 1)

5.4.1 **Combination of air from inside and outdoors.** This section shall apply only to appliances located in confined spaces in buildings not of unusually tight construction. Where the volumes of rooms and spaces are combined for the purpose of providing indoor combustion air, such rooms and spaces shall communicate through permanent openings in compliance with Sections 5.2.3.1 and 5.2.3.2. The required combustion and dilution air shall be obtained by opening the room to the outdoors using a combination of inside and outdoor air, prorated in accordance with Section 5.4.1.6. The ratio of interior spaces shall comply with Section 5.4.1.5. The number, location and ratios of openings connecting the space with the outdoor air shall comply with Sections 5.4.1.1 through 5.4.1.4.

5.4.1.1 **Number and location of openings.** At least two openings shall be provided, one within 300 mm from the ceiling of the room and one within 300 mm from the floor.

5.4.1.2 **Ratio of direct openings.** Where direct openings to the outdoors are provided in accordance with Section 5.3.1, the ratio of direct openings shall be the sum of the net free areas of both direct openings to the outdoors, divided by the sum of the required areas for both such openings as determined in accordance with Section 5.3.1.2.

5.4.1.3 **Ratio of horizontal openings.** Where openings connected to the outdoors through horizontal ducts are provided in accordance with Section 5.3.1, the ratio of horizontal openings shall be the sum of the net free areas of both such openings, divided by the sum of the required areas for both such openings as determined in accordance with Section 5.3.1.3.

5.4.1.4 **Ratio of vertical openings.** Where openings connected to the outdoors through vertical ducts are provided in accordance with Section 5.3.1, the ratio of vertical openings shall be the sum of the net free areas of both such openings, divided by the sum of the required areas for both such openings as determined in accordance with Section 5.3.1.4.

5.4.1.5 **Ratio of interior spaces.** The ratio of interior spaces shall be the available volume of all communicating spaces, divided by the required volume as determined in accordance with Sections 5.2.2 and 5.2.3.

5.4.1.6 **Prorating of inside and outdoor air.** In spaces that utilize a combination of inside and outdoor air, the sum of the ratios of all direct openings, horizontal openings, vertical openings and interior spaces shall equal or exceed 1.

SECTION 5.5
COMBINED USE OF INSIDE AND OUTDOOR AIR (CONDITION 2)

5.5.1 **General.** This section shall apply only to appliances located in unconfined spaces in buildings of unusually tight construction. Combustion air supplied by a combined use of indoor and outdoor air shall be supplied through openings and ducts extending to the appliance room or to the vicinity of the appliance.

5.5.1.1 **Openings and supply ducts.** Openings shall be provided, located and sized in accordance with Sections 5.2.3.1 and 5.2.3.2; additionally, there shall be one opening to the outdoors having a free area of at least 450 mm^2/kW of total input of all appliances in the space.

SECTION 5.6
FORCED COMBUSTION AIR SUPPLY

5.6.1 **General.** Where all combustion air and dilution air is provided by a mechanical forced-air system, the combustion air and dilution air shall be supplied at the minimum rate of 0.70 L/s per kW of combined input rating of all the fuel-burning appliances served. Each of the appliances served shall be electrically interlocked to the mechanical forced-air system so as to prevent operation of the appliances when the mechanical system is not in operation. Where combustion air and dilution air are provided by the building's mechanical ventilation system, the system shall provide the specified combustion/dilution air rate in addition to the required ventilation air.

SECTION 5.7
DIRECT CONNECTION

5.7.1 **General.** Fuel-burning appliances that are listed and labeled for direct combustion air connection to the outdoors shall be installed in accordance with the manufacturer's installation instructions.

SECTION 5.8
COMBUSTION AIR DUCTS

5.8.1 **General.** Combustion air ducts shall:

1. Be of galvanized steel complying with Chapter 4 or of equivalent corrosion-resistant material approved for this application.
   Exception: Within dwelling units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one required fire-block is removed.
2. Have a minimum cross-sectional dimension of 75 mm.
3. Terminate in an unobstructed space allowing free movement of combustion air to the appliances.
4. Have the same cross-sectional areas as the free area of the openings to which they connect.
5. Serve a single appliance enclosure.
6. Not serve both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air.
7. Not be screened where terminating in an attic space.
8. Not slope downward toward the source of combustion air, where serving the upper required combustion air opening.

SECTION 5.9
OPENING OBSTRUCTIONS

5.9.1 **General.** The required size of openings for combustion and dilution air shall be based on the net free area of each opening. The net free area of an opening shall be that specified by the manufacturer of the opening covering. In the absence of such information, openings covered with metal louvers shall be deemed to have a net free area of 75 % of the area of the opening, and openings covered with wood louvers shall be deemed to have a net free area of 25 % of the area of the opening. Louvers and grills shall be fixed in the open position.

Exception: Louvers interlocked with the appliance so that they are proven to be in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to prevent the main burner from igniting if the louvers fail to open during burner startup and to shut down the main burner if the louvers close during operation.

5.9.2 **Dampered openings.** Where the combustion air openings are provided with volume, smoke or fire dampers, the dampers shall be electrically interlocked with the firing cycle of the appliances served, so as to prevent operation of any appliance that draws combustion and dilution air from the room when any of the dampers are closed. Manually operated dampers shall not be installed in combustion air openings.

SECTION 5.10
OPENING LOCATION AND PROTECTION

5.10.1 **General.** Combustion air openings to the outdoors shall comply with the location and protection provisions of Sections 2.1.5 and 2.1.6 applicable to outside air intake openings.

CHAPTER 6
CHIMNEYS AND VENTS

SECTION 6.1
GENERAL

6.1.1 **Scope.** This chapter shall govern the installation, maintenance, repair and approval of factory-built chimneys, chimney liners, vents and connectors. This chapter shall also govern the utilization of masonry chimneys. Gas-fired appliances shall be vented in accordance with the *Saudi Building Code Fuel Gas Requirements*.

6.1.2 **General.** Every fuel-burning appliance shall discharge the products of combustion to a vent, factory-built chimney or masonry chimney, except for appliances vented in accordance with Section 6.4. The chimney or vent shall be designed for the type of appliance being vented.

6.1.2.1 **Oil-fired appliances.** Oil-fired appliances shall be vented in accordance with these requirements and (NFPA 31).

6.1.3 **Masonry chimneys.** Masonry chimneys shall be constructed in accordance with the *Saudi Building Cod*e.

6.1.4 **Positive flow.** Venting systems shall be designed and constructed so as to develop a positive flow adequate to convey all combustion products to the outside atmosphere.

6.1.5 **Design.** Venting systems shall be designed in accordance with this chapter or shall be approved engineered systems.

6.1.6 **Minimum size of chimney or vent.** Except as otherwise provided for in this chapter, the size of the chimney or vent, serving a single appliance, except engineered systems shall have a minimum area equal to the area of the appliance connection.

6.1.7 **Solid fuel appliance flues.** The cross-sectional area of a flue serving a solid fuel-burning appliance shall be not greater than three times the cross-sectional area of the appliance flue collar or flue outlet.

6.1.8 **Abandoned inlet openings.** Abandoned inlet openings in chimneys and vents shall be closed by an approved method.

6.1.9 **Positive pressure.** Where an appliance equipped with a forced or induced draft system creates a positive pressure in the venting system, the venting system shall be designed and listed for positive pressure applications.

6.1.10 **Connection to fireplace.** Connection of appliances to chimney flues serving fireplaces shall be in accordance with Sections 6.1.10.1 through 6.1.10.3.

6.1.10.1 **Closure and access.** A noncombustible seal shall be provided below the point of connection to prevent entry of room air into the flue. Means shall be provided for access to the flue for inspection and cleaning.

6.1.10.2 **Connection to factory-built fireplace flue.** An appliance shall not be connected to a flue serving a factory-built fireplace unless the appliance is specifically listed for such installation. The connection shall be made in accordance with the appliance manufacturer's installation instructions.

6.1.10.3 **Connection to masonry fireplace flue.** A connector shall extend from the appliance to the flue serving a masonry fireplace such that the flue gases are exhausted directly into the flue. The connector shall be provided with access or shall be removable for inspection and cleaning of both the connector and the flue. Listed direct connection devices shall be installed in accordance with their listing.

6.1.11 **Multiple solid fuel prohibited.** A solid fuel-burning appliance or fireplace shall not connect to a chimney passageway venting another appliance.

6.1.12 **Chimney entrance.** Connectors shall connect to a chimney flue at a point not less than 300 mm above the lowest portion of the interior of the chimney flue.

6.1.13 **Cleanouts.** Masonry chimney flues shall be provided with a cleanout opening having a minimum height of 150 mm. The upper edge of the opening shall be located not less than 150 mm below the lowest chimney inlet opening. The cleanout shall be provided with a tight-fitting, noncombustible cover.

Exception: Cleanouts shall not be required for chimney flues serving masonry fireplaces, if such flues are provided with access through the fireplace opening.

6.1.14 **Connections to exhauster.** All appliance connections to a chimney or vent equipped with a power exhauster shall be made on the inlet side of the exhauster. All joints and piping on the positive pressure side of the exhauster shall be listed for positive pressure applications as specified by the manufacturer's installation instructions for the exhauster.

6.1.15 **Fuel-fired appliances.** Masonry chimneys utilized to vent fuel-fired appliances shall be located, constructed and sized as specified in the manufacturer's installation instructions for the appliances being vented.

6.1.16 **Flue lining.** Masonry chimneys shall be lined. The lining material shall be compatible with the type of appliance connected, in accordance with the appliance listing and manufacturer's installation instructions. Listed materials used as flue linings shall be installed in accordance with their listings and the manufacturer's installation instructions.

6.1.16.1 **Residential and low-heat appliances (general).** Flue lining systems for use with residential-type and low-heat appliances shall be limited to the following:

1. Clay flue lining complying with the requirements of (ASTM C 315) or equivalent. Clay flue lining shall be installed in accordance with the *Saudi Building Cod*e.
2. Listed chimney lining systems complying with (UL 1777).
3. Other approved materials that will resist, without cracking, softening or corrosion, flue gases and condensate at temperatures up to 980^{o}C.

6.1.17 **Space around lining.** The space surrounding a flue lining system or other vent installed within a masonry chimney shall not be used to vent any other appliance. This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's installation instructions and these requirements.

6.1.18 **Existing chimneys and vents.** Where an appliance is permanently disconnected from an existing chimney or vent, or where an appliance is connected to an existing chimney or vent during the process of a new installation, the chimney or vent shall comply with Sections 6.1.18.1 through 6.1.18.4.

6.1.18.1 **Size.** The chimney or vent shall be resized as necessary to control flue gas condensation in the interior of the chimney or vent and to provide the appliance or appliances served with the required draft. For the venting of oil-fired appliances to masonry chimneys, the resizing shall be in accordance with (NFPA 31).

6.1.18.2 **Flue passageways.** The flue gas passageway shall be free of obstructions and combustible deposits and shall be cleaned if previously used for venting a solid or liquid fuel-burning appliance or fireplace. The flue liner, chimney inner wall or vent inner wall shall be continuous and shall be free of cracks, gaps, perforations or other damage or deterioration which would allow the escape of combustion products, including gases, moisture and creosote. Where an oil-fired appliance is connected to an existing masonry chimney, such chimney flue shall be repaired or relined in accordance with (NFPA 31).

6.1.18.3 **Cleanout.** Masonry chimneys shall be provided with a cleanout opening complying with Section 6.1.13.

6.1.18.4 **Clearances.** Chimneys and vents shall have air-space clearance to combustibles in accordance with the *Saudi Building Code* and the chimney or vent manufacturer's installation instructions.

Exception: Masonry chimneys equipped with a chimney lining system tested and listed for installation in chimneys in contact with combustibles in accordance with (UL 1777), and installed in accordance with the manufacturer's instructions, shall not be required to have clearance between combustible materials and exterior surfaces of the masonry chimney. Noncombustible fire blocking shall be provided in accordance with the *Saudi Building Code*.

6.1.19 **Multistory prohibited.** Common venting systems for appliances located on more than one floor level shall be prohibited, except where all of the appliances served by the common vent are located in rooms or spaces that are accessed only from the outdoors. The appliance enclosures shall not communicate with the occupiable areas of the building.

6.1.20 **Plastic vent joints.** Plastic pipe and fittings used to vent appliances shall be installed in accordance with the pipe manufacturer's installation instructions and the appliance manufacturer's installation instructions. Solvent cement joints between ABS pipe and fittings shall be cleaned. Solvent cement joints between CPVC and PVC pipe and fittings shall be primed. The primer shall be a contrasting color.

Exception: Where compliance with this section would conflict with the appliance manufacturer's installation instructions.

SECTION 6.2
VENTS

6.2.1 **General.** All vent systems shall be listed and labeled. Type L vents and pellet vents shall be tested in accordance with (UL 641).

6.2.2 **Vent application.** The application of vents shall be in accordance with Table 6.2.2.

Table 6.2.2
Vent Application

Vent Types	Appliance Types
Type L oil vents	Oil-burning appliances listed and labeled for venting with Type L vents; gas appliances listed and labeled for venting with Type B vents.
Pellet vents	Pellet fuel-burning appliances listed and labeled for venting with pellet vents.

6.2.3 **Installation.** Vent systems shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions.

6.2.4 **Vent termination caps required.** Type L vents shall terminate with a listed and labeled cap in accordance with the vent manufacturer's installation instructions.

6.2.5 **Type L vent terminations.** Type L vents shall terminate not less than 600 mm above the highest point of the roof penetration and not less than 600 mm higher than any portion of a building within 3.0 m.

6.2.6 **Minimum vent heights.** Vents shall terminate not less than 1.5 m in vertical height above the highest connected appliance flue collar.

Exceptions:

1. Venting systems of direct vent appliances shall be installed in accordance with the appliance and the vent manufacturer's instructions.
2. Appliances listed for outdoor installations incorporating integral venting means shall be installed in accordance with their listings and the manufacturer's installation instructions.
3. Pellet vents shall be installed in accordance with the appliance and the vent manufacturer's installation instructions.

6.2.7 **Support of vents.** All portions of vents shall be adequately supported for the design and weight of the materials employed.

6.2.8 **Insulation shield.** Where vents pass through insulated assemblies, an insulation shield constructed of not less than 0.6 mm (No. 26 Gage) sheet metal shall be installed to provide clearance between the vent and the insulation material. The clearance shall be not less than the clearance to combustibles specified by the vent manufacturer's installation instructions. Where vents pass through attic space, the shield shall terminate not less than 50 mm above the insulation materials and shall be secured in place to prevent displacement. Insulation shields provided as part of a listed vent system shall be installed in accordance with the manufacturer's installation instructions.

SECTION 6.3
CONNECTORS

6.3.1 **Connectors required.** Connectors shall be used to connect appliances to the vertical chimney or vent, except where the chimney or vent is attached directly to the appliance.

6.3.2 **Location.** Connectors shall be located entirely within the room in which the connecting appliance is located, except as provided for in Section 6.3.10.4. Where

passing through an unheated space, a connector shall not be constructed of single-wall pipe.

6.3.3 **Size.** The connector shall not be smaller than the size of the flue collar supplied by the manufacturer of the appliance. Where the appliance has more than one flue outlet, and in the absence of the manufacturer's specific instructions, the connector area shall be not less than the combined area of the flue outlets for which it acts as a common connector.

6.3.4 **Branch connections.** All branch connections to the vent connector shall be made in accordance with the vent manufacturer's instructions.

6.3.5 **Manual dampers.** Manual dampers shall not be installed in connectors except in chimney connectors serving solid fuel-burning appliances.

6.3.6 **Automatic dampers.** Automatic dampers shall be listed and labeled in accordance with UL 17 for oil-fired heating appliances. The dampers shall be installed in accordance with the manufacturer's installation instructions. An automatic vent damper device shall not be installed on an existing appliance unless the appliance is listed and labeled and the device is installed in accordance with the terms of its listing. The name of the installer and date of installation shall be marked on a label affixed to the damper device.

6.3.7 **Connectors serving two or more appliances.** Where two or more connectors enter a common vent or chimney, the smaller connector shall enter at the highest level consistent with available headroom or clearance to combustible material.

6.3.8 **Vent connector construction.** Vent connectors shall be constructed of metal. The minimum nominal thickness of the connector shall be 0.5 mm (No. 28 Gage) for galvanized steel, 0.6 mm (No. 26 B & S Gage) for copper, and 0.5 mm (No. 24 B & S Gage) for aluminum.

6.3.9 **Chimney connector construction.** Chimney connectors for low-heat appliances shall be of sheet steel pipe having resistance to corrosion and heat not less than that of galvanized steel specified in Table 6.3.9(1). Connectors for medium-heat appliances and high-heat appliances shall be of sheet steel not less than the thickness specified in Table 6.3.9(2).

Table 6.3.9(1)
Minimum Chimney Connector Thickness for Low-Heat Appliances

Diameter of Connector mm	Minimum Nominal Thickness (galvanized) mm
125 and smaller	0.6 (No. 26 Gage)
Larger than 125 and up to 250	0.7 (No. 24 Gage)
Larger than 250 and up to 400	0.9 (No. 22 Gage)
Larger than 400	1.6 (No. 16 Gage)

Table 6.3.9(2)
Minimum Chimney Connector Thickness for Medium- and High-Heat Appliances

Area mm^2	Equivalent Round Diameter mm	Minimum Nominal Thickness mm
0-99,400	0-350	1.6 (No. 16 Gage)
100,000-130,000	380-400	1.9 (No. 14 Gage)
130,300-164,000	430-450	2.6 (No. 12 Gage)
Greater than 164,000	Greater than 450	3.4 (No. 10 Gage)

6.3.10 **Installation.** Connectors shall be installed in accordance with Sections 6.3.10.1 through 6.3.10.6.

6.3.10.1 **Supports and joints.** Connectors shall be supported in an approved manner, and joints shall be fastened with sheet metal screws, rivets or other approved means.

6.3.10.2 **Length.** The maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent.

6.3.10.3 **Connection.** The connector shall extend to the inner face of the chimney or vent liner, but not beyond. A connector entering a masonry chimney shall be cemented to masonry in an approved manner. Where thimbles are installed to facilitate removal of the connector from the masonry chimney, the thimble shall be permanently cemented in place with high-temperature cement.

6.3.10.4 **Connector pass-through.** Chimney connectors shall not pass through any floor or ceiling, nor through a fire-resistance-rated wall assembly. Chimney connectors for domestic-type appliances shall not pass through walls or partitions constructed of combustible material to reach a masonry chimney unless:

1. The connector is labeled for wall pass-through and is installed in accordance with the manufacturer's instructions; or
2. The connector is put through a device labeled for wall pass-through; or
3. The connector has a diameter not larger than 250 mm and is installed in accordance with one of the methods in Table 6.3.10.4. Concealed metal parts of the pass-through system in contact with flue gases shall be of stainless steel or equivalent material that resists corrosion, softening or cracking up to 980ºC.

Table 6.3.10.4
Chimney Connector Systems and Clearances to Combustible Wall Materials for Domestic Heating Appliances[a,b,c,d]

System A 300 mm clearance	A 89 mm-thick brick wall shall be framed into the combustible wall. A 10 mm-thick fireclay liner (ASTM C 315 or equivalent)[e] shall be firmly cemented in the center of the brick wall maintaining a 300 mm clearance to combustibles. The clay liner shall run from the outer surface of the bricks to the inner surface of the chimney liner.
System B 230 mm clearance	A labeled solid-insulated factory-built chimney section 25 mm insulation the same inside diameter as the connector shall be utilized. Sheet metal supports cut to maintain a 230 mm clearance to combustibles shall be fastened to the wall surface and to the chimney section. Fasteners shall not penetrate the chimney flue liner. The chimney length shall be flush with the masonry chimney liner and sealed to the masonry with water in soluble refractory cement. Chimney manufacturers' parts shall be utilized to securely fasten the chimney connector to the chimney section.
System C 150 mm clearance	A sheet metal (minimum number 24 Gage) ventilated thimble having two 25 mm air channels shall be installed with a sheet steel chimney connector (minimum number 24 Gage). Sheet steel supports (minimum number 24 Gage) shall be cut to maintain a 150 mm clearance between the thimble and combustibles. One side of the support shall be fastened to the wall on all sides. Glass-fiber insulation shall fill the 150 mm space between the thimble and the supports.
System D 50 mm clearance	A labeled solid-insulated factory-built chimney section 25 mm insulation with a diameter 50 mm larger than the chimney connector shall be installed with a sheet steel chimney connector (minimum 24 Gage). Sheet metal supports shall be positioned to maintain a 50 mm clearance to combustibles and to hold the chimney connector to ensure that a 25 mm airspace surrounds the chimney connector through the chimney section. The steel support shall be fastened to the wall on all sides and the chimney section shall be fastened to the supports. Fasteners shall not penetrate the liner of the chimney section.

a. Insulation material that is part of the wall pass-through system shall be noncombustible and shall have a thermal conductivity of 0.144 $W/m^2 \cdot {}^oK$ or less.
b. All clearances and thicknesses are minimums.
c. Materials utilized to seal penetrations for the connector shall be noncombustible.
d. Connectors for all systems except System B shall extend through the wall pass-through system to the inner face of the flue liner.
e. (ASTM C 315).

6.3.10.5 **Pitch.** Connectors shall rise vertically to the chimney or vent with a minimum pitch equal to 2-percent slope (one-fourth unit vertical in 12 units horizontal).

6.3.10.6 **Clearances.** Connectors shall have a minimum clearance to combustibles in accordance with Table 6.3.10.6. The clearances specified in Table 6.3.10.6 apply, except where the listing and labeling of an appliance specifies a different clearance, in which case the labeled clearance shall apply. The clearance to combustibles for connectors shall be reduced only in accordance with Section 1.8.

Table 6.3.10.6
Connector Clearances to Combustibles

Type of Appliance	Minimum Clearance mm
Domestic-type appliances	
Chimney and vent connectors	
Electric and oil incinerators	450
Oil and solid fuel appliances	450
Oil appliances labeled for venting with Type L vents	230
Commercial, industrial-type appliances	
Low-heat appliances	
Chimney connectors	
Oil and solid fuel boilers, furnaces and water heaters	450
Oil unit heaters	450
Other low-heat industrial appliances	450
Medium-heat appliances	
Chimney connectors	
All oil and solid fuel appliances 36	900
High-heat appliances Masonry or metal connectors All oil and solid fuel appliances	(As determined by the code official)

SECTION 6.4
DIRECT-VENT, INTEGRAL VENT AND MECHANICAL DRAFT SYSTEMS

6.4.1 **Direct-vent terminations.** Vent terminals for direct-vent appliances shall be installed in accordance with the manufacturer's installation instructions

6.4.2 **Appliances with integral vents.** Appliances incorporating integral venting means shall be installed in accordance with their listings and the manufacturer's installation instructions.

6.4.2.1 **Terminal clearances.** Appliances designed for natural draft venting and incorporating integral venting means shall be located so that a minimum clearance of 230 mm is maintained between vent terminals and from any openings through which combustion products enter the building. Appliances using forced draft venting shall be located so that a minimum clearance of 300 mm is maintained between vent terminals and from any openings through which combustion products enter the building.

6.4.3 **Mechanical draft systems.** Mechanical draft systems of either forced or induced draft design shall comply with Sections 6.4.3.1 through 6.4.3.7.

6.4.3.1 **Forced draft systems.** Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to be gas tight to prevent leakage of combustion products into a building.

6.4.3.2 **Automatic shutoff.** Power exhausters serving automatically-fired appliances shall be electrically connected to each appliance to prevent operation of the appliance when the power exhauster is not in operation.

6.4.3.3 **Termination.** The termination of chimneys or vents equipped with power exhausters shall be located a minimum of 3.0 m from the lot line or from adjacent buildings. The exhaust shall be directed away from the building.

6.4.3.4 **Horizontal terminations.** Horizontal terminations shall comply with the following requirements:

1. Where located adjacent to walkways, the termination of mechanical draft systems shall be not less than 2.0 m above the level of the walkway.
2. Vents shall terminate at least 900 mm above any forced air inlet located within 3.0 m.
3. The vent system shall terminate at least 1.2 m below, 1.2 m horizontally from or 300 mm above any door, window or gravity air inlet into the building.
4. The vent termination point shall not be located closer than 900 mm to an interior corner formed by two walls perpendicular to each other.
5. The vent termination shall not be mounted directly above or within 900 mm horizontally from an oil tank vent or gas meter.
6. The bottom of the vent termination shall be located at least 300 mm above finished grade.

6.4.3.5 **Vertical terminations.** Vertical terminations shall comply with the following requirements:

1. Where located adjacent to walkways, the termination of mechanical draft systems shall be not less than 2.14 m above the level of the walkway.
2. Vents shall terminate at least 900 mm above any forced air inlet located within 3.0 m.
3. Where the vent termination is located below an adjacent roof structure, the termination point shall be located at least 900 mm from such structure.
4. The vent shall terminate at least 1.2 m below, 1.2 m horizontally from, or 300 mm above any door, window or gravity air inlet for the building.
5. A vent cap shall be installed to prevent rain from entering the vent system.
6. The vent termination shall be located at least 900 mm horizontally from any portion of the roof structure.

6.4.3.6 **Exhauster connections.** An appliance vented by natural draft shall not be connected into a vent, chimney or vent connector on the discharge side of a mechanical flue exhauster.

6.4.3.7 **Exhauster sizing.** Mechanical flue exhausters and the vent system served shall be sized and installed in accordance with the manufacturer's installation instructions.

6.4.3.8 **Mechanical draft systems for manually fired appliances and fireplaces.** A mechanical draft system shall be permitted to be used with manually fired appliances and fireplaces where such system complies with all of the following requirements:

1. The mechanical draft device shall be listed and installed in accordance with the manufacturer's installation instructions.
2. A device shall be installed that produces visible and audible warning upon failure of the mechanical draft device or loss of electrical power, at any time that the mechanical draft device is turned on. This device shall be equipped with a battery backup if it receives power from the building wiring.
3. A smoke detector shall be installed in the room with the appliance or fireplace. This device shall be equipped with a battery backup if it receives power from the building wiring.

SECTION 6.5
FACTORY-BUILT CHIMNEYS

6.5.1 **Listing.** Factory-built chimneys shall be listed and labeled and shall be installed and terminated in accordance with the manufacturer's installation instructions.

6.5.2 **Solid fuel appliances.** Factory-built chimneys for use with solid fuel-burning appliances shall comply with the Type HT requirements of (UL 103).

Exception: Chimneys for use with fireplace stoves listed only to (UL 737) shall comply with the requirements of (UL 103).

6.5.3 **Factory-built fireplaces.** Chimneys for use with factory-built fireplaces shall comply with the requirements of (UL 127).

6.5.4 **Support.** Where factory-built chimneys are supported by structural members, such as joists and rafters, such members shall be designed to support the additional load.

6.5.5 **Medium-heat appliances.** Factory-built chimneys for medium-heat appliances producing flue gases having a temperature above 530ºC, measured at the entrance to the chimney, shall comply with (UL 959).

6.5.6 **Decorative shrouds.** Decorative shrouds shall not be installed at the termination of factory-built chimneys except where such shrouds are listed and labeled for use with the specific factory-built chimney system and are installed in accordance with Section 1.4.1.

SECTION 6.6
METAL CHIMNEYS

6.6.1 **General.** Metal chimneys shall be constructed and installed in accordance with (NFPA 211).

CHAPTER 7
SPECIFIC APPLIANCES

SECTION 7.1
GENERAL

7.1.1 **Scope.** This chapter shall govern the approval, design, installation, construction, maintenance, alteration and repair of the appliances and equipment specifically identified herein and factory-built fireplaces. The approval, design, installation, construction, maintenance, alteration and repair of gas-fired appliances shall be regulated by the *Saudi Fuel Gas Requirements*.

7.1.2 **General.** The requirements of this chapter shall apply to the mechanical equipment and appliances regulated by this chapter, in addition to the other requirements of these requirements.

7.1.3 **Hazardous locations.** Fireplaces and solid fuel-burning appliances shall not be installed in hazardous locations.

7.1.4 **Fireplace accessories.** Listed fireplace accessories shall be installed in accordance with the conditions of the listing and the manufacturer's installation instructions.

SECTION 7.2
MASONRY FIREPLACES

7.2.1 **General.** Masonry fireplaces shall be constructed in accordance with the *Saudi Building Code*.

SECTION 7.3
FACTORY-BUILT FIREPLACES

7.3.1 **General.** Factory-built fireplaces shall be listed and labeled and shall be installed in accordance with the conditions of the listing. Factory-built fireplaces shall be tested in accordance with (UL 127).

7.3.2 **Hearth extensions.** Hearth extensions of approved factory-built fireplaces and fireplace stoves shall be installed in accordance with the listing of the fireplace. The hearth extension shall be readily distinguishable from the surrounding floor area.

7.3.3 **Unvented gas log heaters.** An unvented gas log heater shall not be installed in a factory-built fireplace unless the fireplace system has been specifically tested, listed and labeled for such use in accordance with (UL 127).

SECTION 7.4
PELLET FUEL-BURNING APPLIANCES

7.4.1 **General.** Pellet fuel-burning appliances shall be listed and labeled and shall be installed in accordance with the terms of the listing.

SECTION 7.5
FIREPLACE STOVES AND ROOM HEATERS

7.5.1 **General.** Fireplace stoves and solid-fuel-type room heaters shall be listed and labeled and shall be installed in accordance with the conditions of the listing. Fireplace stoves shall be tested in accordance with (UL 737). Solid-fuel-type room heaters shall be tested in accordance with (UL 1482). Fireplace inserts intended for installation in fireplaces shall be listed and labeled in accordance with the requirements of (UL 1482) and shall be installed in accordance with the manufacturer's installation instructions.

7.5.2 **Connection to fireplace.** The connection of solid fuel appliances to chimney flues serving fireplaces shall comply with Sections 6.1.7 and 6.1.10.

SECTION 7.6
FACTORY-BUILT BARBECUE APPLIANCES

7.6.1 **General.** Factory-built barbecue appliances shall be of an approved type and shall be installed in accordance with the manufacturer's installation instructions, this chapter and the *Saudi Fuel Gas Requirement*s.

SECTION 7.7
INCINERATORS

7.7.1 **General.** Incinerators shall be listed and labeled in accordance with (UL 791) and shall be installed in accordance with the manufacturer's installation instructions.

SECTION 7.8
COOLING TOWERS, EVAPORATIVE CONDENSERS AND FLUID COOLERS

7.8.1 **General.** A cooling tower used in conjunction with an air-conditioning appliance shall be installed in accordance with the manufacturer's installation instructions.

7.8.2 **Access.** Cooling towers, evaporative condensers and fluid coolers shall be provided with ready access.

7.8.3 **Location.** Cooling towers, evaporative condensers and fluid coolers shall be located to prevent the discharge vapor plumes from entering occupied spaces. Plume discharges shall be not less than 1.5 m above or 6.0 m away from any ventilation inlet to a building. Location on the property shall be as required for buildings in accordance with the *Saudi Building Code*.

7.8.4 **Support and anchorage.** Supports for cooling towers, evaporative condensers and fluid coolers shall be designed in accordance with the *Saudi Building Code*. Seismic restraints shall be as required by the *Saudi Building Code*.

7.8.5 **Water supply.** Water supplies and protection shall be as required by the *Saudi Plumbing Requirements*.

7.8.6 **Drainage.** Drains, overflows and blow-down provisions shall be indirectly connected to an approved disposal location. Discharge of chemical waste shall be approved by the appropriate regulatory authority.

7.8.7 **Refrigerants and hazardous fluids.** Heat exchange equipment that contains a refrigerant and that is part of a closed refrigeration system shall comply with Chapter 9. Heat exchange equipment containing heat transfer fluids which are flammable, combustible or hazardous shall comply with the *Saudi Fire Code*.

SECTION 7.9
VENTED WALL FURNACES

7.9.1 **General.** Vented wall furnaces shall be installed in accordance with their listing and the manufacturer's installation instructions. Oil-fired furnaces shall be tested in accordance with (UL 730).

7.9.2 **Location.** Vented wall furnaces shall be located so as not to cause a fire hazard to walls, floors, combustible furnishings or doors. Vented wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building.

7.9.3 **Door swing.** Vented wall furnaces shall be located so that a door cannot swing within 300 mm of an air inlet or air outlet of such furnace measured at right angles to the opening. Doorstops or door closers shall not be installed to obtain this clearance.

7.9.4 **Ducts prohibited.** Ducts shall not be attached to wall furnaces. Casing extension boots shall not be installed unless listed as part of the appliance.

7.9.5 **Manual shutoff valve.** A manual shutoff valve shall be installed ahead of all controls.

7.9.6 **Access.** Vented wall furnaces shall be provided with access for cleaning of heating surfaces, removal of burners, replacement of sections, motors, controls, filters and other working parts, and for adjustments and lubrication of parts requiring such attention. Panels, grilles and access doors that must be removed for normal servicing operations shall not be attached to the building construction.

SECTION 7.10
FLOOR FURNACES

7.10.1 **General.** Floor furnaces shall be installed in accordance with their listing and the manufacturer's installation instructions. Oil-fired furnaces shall be tested in accordance with (UL 729).

7.10.2 **Placement.** Floor furnaces shall not be installed in the floor of any aisle or passageway of any auditorium, public hall, place of assembly, or in any egress element from any such room or space. With the exception of wall register models, a floor furnace shall not be placed closer than 150 mm to the nearest wall, and wall register models shall not be placed closer than 150 mm to a corner. The furnace shall be placed such that a drapery or similar combustible object will not be nearer than 300 mm to any portion of the register of the furnace. Floor furnaces shall not be installed in concrete floor construction built on grade. The controlling thermostat for a floor furnace shall be located within the same room or space as the floor furnace or shall be located in an adjacent room or space that is permanently open to the room or space containing the floor furnace.

7.10.3 **Bracing.** The floor around the furnace shall be braced and headed with a support framework design in accordance with the *Saudi Building Code*.

7.10.4 **Clearance.** The lowest portion of the floor furnace shall have not less than a 150 mm clearance from the grade level; except where the lower 150 mm portion of the floor furnace is sealed by the manufacturer to prevent entrance of water, the minimum clearance shall be reduced to not less than 50 mm. Where these clearances are not present, the ground below and to the sides shall be excavated to form a pit under the furnace so that the required clearance is provided beneath the lowest portion of the furnace. A 300 mm minimum clearance shall be provided on all sides except the control side, which shall have a 450 mm minimum clearance.

SECTION 7.11
INFRARED RADIANT HEATERS

7.11.1 **Support.** Infrared radiant heaters shall be safely and adequately fixed in an approved position independent of fuel and electric supply lines. Hangers and brackets shall be of noncombustible material.

7.11.2 **Clearances.** Heaters shall be installed with clearances from combustible material in accordance with the manufacturer's installation instructions.

SECTION 7.12
CLOTHES DRYERS

7.12.1 **General.** Clothes dryers shall be installed in accordance with the manufacturer's installation instructions. Electric residential clothes dryers shall be tested in accordance with an approved test standard. Electric commercial clothes dryers shall be tested in accordance with (UL 1240).

7.12.2 **Exhaust required.** Clothes dryers shall be exhausted in accordance with Section 3.4.

7.12.3 **Clearances.** Clothes dryers shall be installed with clearance to combustibles in accordance with the manufacturer's instructions.

SECTION 7.13
SAUNA HEATERS

7.13.1 **Location and protection.** Sauna heaters shall be located so as to minimize the possibility of accidental contact by a person in the room.

7.13.1.1 **Guards.** Sauna heaters shall be protected from accidental contact by an approved guard or barrier of material having a low coefficient of thermal conductivity. The guard shall not substantially affect the transfer of heat from the heater to the room.

7.13.2 **Installation.** Sauna heaters shall be listed and labeled and shall be installed in accordance with their listing and the manufacturer's installation instructions.

7.13.3 **Access.** Panels, grilles and access doors that are required to be removed for normal servicing operations shall not be attached to the building.

7.13.4 **Heat and time controls.** Sauna heaters shall be equipped with a thermostat that will limit room temperature to 90°C. If the thermostat is not an integral part of the

sauna heater, the heat-sensing element shall be located within 150 mm of the ceiling. If the heat-sensing element is a capillary tube and bulb, the assembly shall be attached to the wall or other support, and shall be protected against physical damage.

7.13.4.1 **Timers.** A timer, if provided to control main burner operation, shall have a maximum operating time of 1 hour. The control for the timer shall be located outside the sauna room.

7.13.5 **Sauna room.** A ventilation opening into the sauna room shall be provided. The opening shall be not less than 100 mm by 200 mm located near the top of the door into the sauna room.

7.13.5.1 **Warning notice.** The following permanent notice, constructed of approved material, shall be mechanically attached to the sauna room on the outside:

Warning: Do Not Exceed 30 Minutes in Sauna. Excessive Exposure can be Harmful to Health. Any Person with Poor Health Should Consult a Physician Before Using Sauna.

The words shall contrast with the background and the wording shall be in letters not less than 6 mm high.

Exception: This section shall not apply to one- and two-family dwellings.

SECTION 7.14
ENGINE AND GAS TURBINE-POWERED EQUIPMENT AND APPLIANCES

7.14.1 **General.** The installation of liquid-fueled stationary internal combustion engines and gas turbines, including fuel storage and piping, shall meet the requirements of (NFPA 37).

7.14.2 **Powered equipment and appliances.** Permanently installed equipment and appliances powered by internal combustion engines and turbines shall be installed in accordance with the manufacturer's installation instructions and (NFPA 37).

SECTION 7.15
POOL AND SPA HEATERS

7.15.1 **General.** Pool and spa heaters shall be installed in accordance with the manufacturer's installation instructions. Oil-fired pool and spa heaters shall be tested in accordance with (UL 726). Electric pool and spa heaters shall be tested in accordance with (UL 1261).

SECTION 7.16
COOKING APPLIANCES

7.16.1 **Cooking appliances.** Cooking appliances that are designed for permanent installation, including ranges, ovens, stoves, broilers, grills, fryers, griddles and barbecues, shall be listed, labeled and installed in accordance with the manufacturer's installation instructions. Oil-burning stoves shall be tested in accordance with (UL 896).

7.16.2 **Prohibited location.** Cooking appliances designed, tested, listed and labeled for use in commercial occupancies shall not be installed within dwelling units or within any area where domestic cooking operations occur.

7.16.3 **Domestic appliances.** Cooking appliances installed within dwelling units and within areas where domestic cooking operations occur shall be listed and labeled as household-type appliances for domestic use.

SECTION 7.17
FORCED-AIR WARM-AIR FURNACES

7.17.1 **Forced-air furnaces.** Oil-fired furnaces shall be tested in accordance with (UL 727). Electric furnaces shall be tested in accordance with (UL 1995). Solid fuel furnaces shall be tested in accordance with (UL 391). Forced-air furnaces shall be installed in accordance with the listings and the manufacturer's installation instructions.

7.17.2 **Minimum duct sizes.** The minimum unobstructed total area of the outside and return air ducts or openings to a forced-air warm-air furnace shall be not less than 4400 mm^2/kW output rating capacity of the furnace and not less than that specified in the furnace manufacturer's installation instructions. The minimum unobstructed total area of supply ducts from a forced-air warm-air furnace shall not be less than 4400 mm^2/kW output rating capacity of the furnace and not less than that specified in the furnace manufacturer's installation instructions.
Exception: The total area of the supply air ducts and outside and return air ducts shall not be required to be larger than the minimum size required by the furnace manufacturer's installation instructions.

7.17.3 **Heat pumps.** The minimum unobstructed total area of the outside and return air ducts or openings to a heat pump shall be not less than 13 200 mm^2/kW output rating or as indicated by the conditions of listing of the heat pump. Electric heat pumps shall be tested in accordance with (UL 1995).

7.17.4 **Dampers.** Volume dampers shall not be placed in the air inlet to a furnace in a manner that will reduce the required air to the furnace.

7.17.5 **Circulating air ducts for forced-air warm-air furnaces.** Circulating air for fuel-burning, forced-air-type, warm-air furnaces shall be conducted into the blower housing from outside the furnace enclosure by continuous air-tight ducts.

7.17.6 **Prohibited sources.** Outside or return air for a forced-air heating system shall not be taken from the following locations:

1. Closer than 3.0 m from an appliance vent outlet, a vent opening from a plumbing drainage system or the discharge outlet of an exhaust fan, unless the outlet is 900 mm above the outside air inlet.
2. Where there is the presence of objectionable odors, fumes or flammable vapors; or where located less than 3.0 m above the surface of any abutting public way or driveway; or where located at grade level by a sidewalk, street, alley or driveway.
3. A hazardous or unsanitary location or a refrigeration machinery room as defined in these requirements.
4. A room or space, the volume of which is less than 25 % of the entire volume served by such system. Where connected by a permanent opening having an area sized in accordance with Sections 7.18.2 and 7.18.3, adjoining rooms or spaces shall be considered as a single room or space for the purpose of determining the volume of such rooms or spaces.

Exception: The minimum volume requirements shall not apply where the amount of return air taken from a room or space is less than or equal to the amount of supply air delivered to such room or space.

5. A closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room or furnace room.

6. A room or space containing a fuel-burning appliance where such room or space serves as the sole source of return air.

Exceptions:

1. This shall not apply where the fuel-burning appliance is a direct-vent appliance.

2. This shall not apply where the room or space complies with the following requirements:

2.1 The return air shall be taken from a room or space having a volume exceeding 9 L/W of combined input rating of all fuel-burning appliances therein.

2.2 The volume of supply air discharged back into the same space shall be approximately equal to the volume of return air taken from the space.

2.3 Return-air inlets shall not be located within 3.0 m of any appliance firebox or draft hood in the same room or space.

3. This shall not apply to rooms or spaces containing solid fuel-burning appliances, provided that return-air inlets are located not less than 3.0 m from the firebox of such appliances.

7.17.7 **Outside opening protection.** Outdoor air intake openings shall be protected in accordance with Section 2.1.6.

7.17.8 **Return-air limitation.** Return air from one dwelling unit shall not be discharged into another dwelling unit.

SECTION 7.18
CONVERSION BURNERS

7.18.1 **Conversion burners.** The installation of conversion burners shall conform to (ANSI Z21.8).

SECTION 7.19
UNIT HEATERS

7.19.1 **General.** Unit heaters shall be installed in accordance with the listing and the manufacturer's installation instructions. Oil-fired unit heaters shall be tested in accordance with (UL 731).

7.19.2 **Support.** Suspended-type unit heaters shall be supported by elements that are designed and constructed to accommodate the weight and dynamic loads. Hangers and brackets shall be of noncombustible material. Suspended-type oil-fired unit heaters shall be installed in accordance with (NFPA 31).

7.19.3 **Ductwork.** A unit heater shall not be attached to a warm-air duct system unless listed for such installation.

SECTION 7.20
VENTED ROOM HEATERS

7.20.1 **General.** Vented room heaters shall be listed and labeled and shall be installed in accordance with the conditions of the listing and the manufacturer's instructions.

SECTION 7.21
KEROSENE AND OIL-FIRED STOVES

7.21.1 **General.** Kerosene and oil-fired stoves shall be listed and labeled and shall be installed in accordance with the conditions of the listing and the manufacturer's installation instructions. Kerosene and oil-fired stoves shall comply with (NFPA 31). Oil-fired stoves shall be tested in accordance with (UL 896).

SECTION 7.22
SMALL CERAMIC KILNS

7.22.1 **General.** The provisions of this section shall apply to kilns that are used for ceramics, have a maximum interior volume of 0.50 m^3 and are used for hobby and noncommercial purposes.

7.22.1.1 **Installation.** Kilns shall be installed in accordance with the manufacturer's installation instructions and the provisions of these requirements.

SECTION 7.23
STATIONARY FUEL CELL POWER PLANTS

7.23.1 **General.** Stationary fuel cell power plants having a power output not exceeding 1000 kW, shall be tested in accordance with (ANSI Z21.83) and shall be installed in accordance with the manufacturer's installation instructions and (NFPA 853).

SECTION 7.24
MASONRY HEATERS

7.24.1 **General.** Masonry heaters shall be constructed in accordance with the *Saudi Building Code*.

SECTION 7.25
SPECIAL PROVISIONS FOR DISABLED PEOPLE IN HEATING FACILITIES

7.25.1 **General.** When designing any central heating system, provisions shall be made for the requirements for the disabled people according to the type and severity of the disability. Cold air currents between rooms and through doors and windows shall not be allowed. This shall be done by sealing, using weather strips.

7.25.2 **Thermal requirements of disabled people.**

1. Heating equipment shall be able to provide the following temperatures at a height of 1 m above the floor according to the use of the room, provided that the temperature in living rooms does not exceed 21°C at a height of 0.2 m above the floor:
   - 21°C in living rooms and dining rooms.
   - 17°C in bedrooms, kitchens and movement spaces.
2. In cases of paraplegia, heating facilities shall continually provide higher temperatures than in paragraph 1 in bathrooms and toilettes.

3. Vertical temperature gradients in the same room shall be minimized.
4. Cold floors shall be avoided by using covering materials such as carpet or cork.

7.25.3 **Central heating systems and local heating devices.**

1. Under-floor heating. Floor temperature shall not exceed 24°C. In buildings intended for use by disabled children, the floor temperature shall not exceed 21°C. When the floor is covered by carpet, the floor temperature shall be raised to compensate for that.
2. Panel heating. This heating system shall be designed so as to be safe and to withstand impacts by wheelchairs.
3. Ceiling heating:
   a) This type of heating systems shall be provided with air thermostats capable of automatically controlling the temperature by stopping the system upon exceeding the set temperature limit.
   b) This type of heating system may be installed at a height up to 2.4 m above the floor.
   c) This type of heating system is preferably used in buildings intended for disabled children, especially those spending long time on the floor. Also, this type of heating system raises the temperature of furniture and surfaces as a result of received radiation from radiators.
   d) Windows and openings shall be well distributed when this heating system is used, due to possible disturbance in temperature distribution in the room brought about by air currents across windows and openings.
4. Heating by radiators:
   a) The temperature of the front surface of the radiator shall be low as to permit touching the radiator without harm or injury to the disabled person.
   b) In regard of the above, disabled people shall have the opportunity to reach windows and to look through them easily to the outside without obstruction by other bodies. Therefore, such types of radiators are preferably installed on other walls instead of being located below a window.
   c) Radiators shall be installed as near to the floor as possible, in order to reduce the effect of cold air currents and to protect disabled persons, especially those on wheelchairs, from being hurt by the heat from radiators.
5. Heating by warm air:
   a) When using this type of heaters, care shall be taken to reduce as much as possible dispersion of dust, by using filters of definite specifications or low-speed fans.
   b) Hot air outlets shall be located opposite to cold air inlets in order to reduce cold air currents.
   c) Provisions shall be made to prevent hot air flow from causing damage to furniture and decorations.
6. Fireplaces:
   a) Fireplaces shall be surrounded by guards, in order to protect disabled persons from possible hazards. Fireplaces shall also be provided with large-size trays capable of accommodating large quantities of ash, disposal thereof and cleaning.
7. Heating by stand-alone heaters:
   a) This type of heaters is not preferred for disabled people due to possible fire and indoor air pollution hazards. Nevertheless, if need makes it necessary to use such heaters, due care shall be taken to protect disabled persons, especially those on wheelchairs, against collision with them. Also,

adequate ventilation shall be provided to remove hazardous combustion gases.

b) Local stationary heaters shall be preferred to mobile heaters, because of the easier removal of hazardous combustion gases, provided that protecting guards are installed around them.

SECTION 7.26
VAPOR-COMPRESSION AIR CONDITIONING SYSTEMS

7.26.1 General

7.26.1.1 **Design stage.** During the design phase, the designer shall keep in mind that energy efficiency shall be a prime consideration. The system shall be effective in delivering the required conditions to each thermal zone and/or application. Design features shall be flexible and capable of modification should there be a change in functionality within the building at a later stage. The designer shall assess the overall concept of system design, based on all given standards and specific user information, and shall prepare a report for preliminary discussion with the project manager.

7.26.1.2 **System features.** The air conditioning system shall include facilities to enable the following:

- Provision of a healthy internal environment, ensuring optimum air quality and providing safe and comfortable working conditions.
- Optimized cost-effective outside air economy cycle.
- Economic after-hours operation for individual areas of the building.
- Increased room-air circulation by the use of multi-speed, reversible ceiling fans in areas of high occupancy or thermal loads.

7.26.1.3 **Cooling systems.** Cooling systems shall be provided for requested areas or to specific applications as required. Again, energy efficiency shall be a prime consideration. Plant centralization is preferred and must be considered together with plant access and system flexibility.

7.26.1.3.1 **Chillers.** Selected chillers shall be supplied with at least 15% in excess of calculated requirements. Generally, chillers above a cooling capacity of 600 kW (170 tons) shall be water-cooled. Chillers below this capacity shall be air-cooled. The following conditions shall be met:

- The chiller shall be supplied with factory-installed, variable-speed/soft-start and with electronic expansion valve.
- The selection should also incorporate the capability of chiller staging to suit operation under partial loads as, for example, during after-hours and weekends.
- The refrigeration plant type shall be based on a life-cycle analysis of the most effective and economically viable alternatives available.
- Compressors shall be accessible and of a hermetically sealed type, with all rotating parts statically and dynamically balanced.
- Closed cooling systems are preferred for low-capacity heat rejection in lieu of open cooling-tower systems.
- Cathodic protection shall be provided on all chillers. Anode material like aluminum depends on the metals used in the construction of the unit.

7.26.1.3.2 **Refrigerants.** All equipment shall be specified with HCFC or HFC refrigerants. Equipment requiring the use of CFC refrigerants shall not be specified.

7.26.1.3.3 **Cooling coils.** Where possible, manufactured standard coil dimensions are to be utilized, rated 10% over the required capacity.

7.26.1.4 **Air handling units.** Air handling units shall meet the following requirements:

- They shall be installed in accordance with the manufacturer’s instructions.
- Fan impellers shall be statically and dynamically balanced at the design speed

in the factory.

- The motor-fan assembly shall be suspended on isolating pads or springs for vibration suppression.
- A vibration isolation system shall be used to prevent vibration from being transmitted from the fan discharge to the casing.
- Fan bearings shall be self-aligning, pillow-block, relubricatable ball type, selected for an average life of 200,000 hours.

SECTION 7.27
EVAPORATIVE AIR COOLERS

7.27.1 **General.** Evaporative cooling is an environmentally safe and energy-efficient cooling method; in the peak cooling months of the year it demands only about one-fifth to one-fourth as much energy as refrigeration. It may, and should, be used alone or in a dual cooling system in conjunction with refrigerated air conditioning.

7.27.1 **System requirements.** The following design features of the system should result in an evaporative cooler with higher energy and water saving, longer life and higher-long-term cost effectiveness:

- Operate in two-stage (indirect/direct) cooling mode.
- Use an on/off thermostat to operate/stop the cooler.
- Design for slower air movement (by using a two-speed fan).
- Select the correct size of the water-circulating pump.
- Use thick porous bacteria and fungi resistant pad.
- Provide for adequate homogeneous wetting of the pad.
- Use a bleed-off system on the water circulation loop with hard water.
- Use highly reflective, corrosion-resistant cabinet.
- Use higher operating voltage than household current.
- Discharge appropriately the wet exhaust air; this will further reduce the heat gain and hence the cooling load.

CHAPTER 8
BOILERS, WATER HEATERS AND PRESSURE VESSELS

SECTION 8.1
GENERAL

8.1.1 **Scope.** This chapter shall govern the installation, alteration and repair of boilers, water heaters and pressure vessels.

Exceptions:

1. Pressure vessels used for unheated water supply.
2. Portable unfired pressure vessels and Interstate Commerce Commission containers.
3. Containers for bulk oxygen and medical gas.
4. Unfired pressure vessels having a volume of 0.15 m^3 or less operating at pressures not exceeding 1700 kPa and located within occupancies of Groups B, F, H, M, R, S and U.
5. Pressure vessels used in refrigeration systems that are regulated by Chapter 9 of these requirements.
6. Pressure tanks used in conjunction with coaxial cables, telephone cables, power cables and other similar humidity control systems.
7. Any boiler or pressure vessel subject to inspection by governmental inspectors.

SECTION 8.2
WATER HEATERS

8.2.1 **General.** Potable water heaters and hot water storage tanks shall be listed and labeled and installed in accordance with the manufacturer's installation instructions, the *Saudi Building Code Sanitary Requirements* and these requirements. All water heaters shall be capable of being removed without first removing a permanent portion of the building structure. The potable water connections and relief valves for all water heaters shall conform to the requirements of the *Saudi Building Code Sanitary Requirements*. Domestic electric water heaters shall comply with (UL 174 or UL 1453). Commercial electric water heaters shall comply with (UL 1453). Oil-fired water heaters shall comply with (UL 732).

8.2.2 **Water heaters utilized for space heating.** Water heaters utilized both to supply potable hot water and provide hot water for space-heating applications shall be listed and labeled for such applications by the manufacturer and shall be installed in accordance with the manufacturer's installation instructions and the *Saudi Building Code Sanitary Requirements*.

8.2.2.1 **Sizing.** Water heaters utilized for both potable water heating and space-heating applications shall be sized to prevent the space-heating load from diminishing the required potable water-heating capacity.

8.2.2.2 **Scald protection.** Where a combination potable water-heating and space-heating system requires water for space heating at temperatures higher than 60°C, a tempering valve shall be provided to temper the water supplied to the potable hot water distribution system to a temperature of 60°C or less.

8.2.3 **Supplemental water-heating devices.** Potable water heating devices that utilize refrigerant-to-water heat exchangers shall be approved and installed in accordance with the *Saudi Building Code Sanitary Requirements* and the manufacturer's installation instructions.

SECTION 8.3 PRESSURE VESSELS

8.3.1 **General.** All pressure vessels shall bear the label of an approved agency and shall be installed in accordance with the manufacturer's installation instructions.

8.3.2 **Piping.** All piping materials, fittings, joints, connections and devices associated with systems utilized in conjunction with pressure vessels shall be designed for the specific application and shall be approved.

8.3.3 **Welding.** Welding on pressure vessels shall be performed by approved welders in compliance with nationally recognized standards.

SECTION 8.4 BOILERS

8.4.1 **Standards.** Oil-fired boilers and their control systems shall be listed and labeled in accordance with (UL 726). Electric boilers and their control systems shall be listed and labeled in accordance with (UL 834). Boilers shall be designed and constructed in accordance with the requirements of (ASME CSD-1 and as applicable, the ASME *Boiler and Pressure Vessel Requirements*, Sections I, II, V, and IX; NFPA 8501; NFPA 8502 or NFPA 8504).

8.4.2 **Installation.** In addition to the requirements of these requirements, the installation of boilers shall conform to the manufacturer's instructions. Operating instructions of a permanent type shall be attached to the boiler. Boilers shall have all controls set, adjusted and tested by the installer. The manufacturer's rating data and the nameplate shall be attached to the boiler.

8.4.3 **Working clearance.** Clearances shall be maintained around boilers, generators, heaters, tanks and related equipment and appliances so as to permit inspection, servicing, repair, replacement and visibility of all gauges. When boilers are installed or replaced, clearance shall be provided to allow access for inspection, maintenance and repair. Passageways around all sides of boilers shall have an unobstructed width of not less than 450 mm unless otherwise approved.

8.4.3.1 **Top clearance.** High-pressure steam boilers having a steam-generating capacity in excess of 2300 kg/h or having a heating surface in excess of 90 m^2 or input in excess of 1450 kW shall have a minimum clearance of 200 cm from the top of the boiler to the ceiling. Steam-heating boilers and hot-water-heating boilers that exceed one of the following limits: 1500 kW; 2300 kg/h capacity or a 90 m^2 heating surface; and high-pressure steam boilers that do not exceed one of the following limits: 1500 kW input; 2300 kg/h capacity or a 90 m^2 heating surface; and all boilers with manholes on top of the boiler, shall have a minimum clearance of 90 cm from the top of the boiler to the ceiling. Package boilers, steam-heating boilers and hot-water-heating boilers without manholes on top of the shell and not exceeding one of the limits of this section shall have a minimum clearance of 60 cm from the ceiling.

8.4.4 **Mounting.** Equipment shall be set or mounted on a level base capable of supporting and distributing the weight contained thereon. Boilers, tanks and equipment shall be secured in accordance with the manufacturer's installation instructions.

8.4.5 **Floors.** Boilers shall be mounted on floors of noncombustible construction, unless listed for mounting on combustible flooring.

8.4.6 **Boiler rooms and enclosures.** Boiler rooms and enclosures and access thereto shall comply with the *Saudi Building Code* and Chapter 1 of these requirements. Boiler rooms shall be equipped with a floor drain or other approved means for disposing of liquid waste.

8.4.7 **Operating adjustments and instructions.** Hot water and steam boilers shall have all operating and safety controls set and operationally tested by the installing contractor. A complete control diagram and boiler operating instructions shall be furnished by the installer for each installation.

SECTION 8.5 BOILER CONNECTIONS

8.5.1 **Valves.** Every boiler or modular boiler shall have a shutoff valve in the supply and return piping. For multiple boiler or multiple modular boiler installations, each boiler or modular boiler shall have individual shutoff valves in the supply and return piping.

Exception: Shutoff valves are not required in a system having a single low-pressure steam boiler.

8.5.2 **Potable water supply.** The water supply to all boilers shall be connected in accordance with the *Saudi Building Code Sanitary Requirements*.

SECTION 8.6 SAFETY AND PRESSURE RELIEF VALVES AND CONTROLS

8.6.1 **Safety valves for steam boilers.** All steam boilers shall be protected with a safety valve.

8.6.2 **Safety relief valves for hot water boilers.** Hot water boilers shall be protected with a safety relief valve.

8.6.3 **Pressure relief for pressure vessels.** All pressure vessels shall be protected with a pressure relief valve or pressure-limiting device as required by the manufacturer's installation instructions for the pressure vessel.

8.6.4 **Pressure relief valves for positive displacement pumps:** pressure relief valves shall be installed with fuel delivery positive displacement pumps to relief to a line leading to a tank.

8.6.5 **Approval of safety and safety relief valves.** Safety and safety relief valves shall be listed and labeled, and shall have a minimum rated capacity for the equipment or appliances served. Safety and safety relief valves shall be set at a maximum of the nameplate pressure rating of the boiler or pressure vessel.

8.6.6 **Installation.** Safety or relief valves shall be installed directly into the safety or relief valve opening on the boiler or pressure vessel. Valves shall not be located on either side of a safety or relief valve connection. The relief valve shall discharge by gravity.

8.6.7 **Safety and relief valve discharge.** Safety and relief valve discharge pipes shall be of rigid pipe that is approved for the temperature of the system. The discharge pipe shall be the same diameter as the safety or relief valve outlet. Safety and relief valves shall not discharge so as to be a hazard, a potential cause of damage or otherwise a nuisance. High-pressure-steam safety valves shall be vented to the outside of the structure. Where a low-pressure safety valve or a relief valve discharges to the drainage system, the installation shall conform to the *Saudi Building Code Sanitary Requirements*.

8.6.8 **Boiler safety devices.** Boilers shall be equipped with controls and limit devices as required by the manufacturer's installation instructions and the conditions of the listing.

8.6.9 **Electrical requirements.** The power supply to the electrical control system shall be from a two-wire branch circuit that has a grounded conductor, or from an isolation transformer with a two-wire secondary. Where an isolation transformer is provided, one conductor of the secondary winding shall be grounded. Control voltage shall not exceed 300 volts nominal, line to line. Control and limit devices shall interrupt the ungrounded side of the circuit. A means of manually disconnecting the control circuit shall be provided and controls shall be arranged so that when de-energized, the burner shall be inoperative. Such disconnecting means shall be capable of being locked in the off position and shall be provided with ready access.

SECTION 8.7
BOILER LOW-WATER CUTOFF

8.7.1 **General.** All steam and hot water boilers shall be protected with a low-water cutoff control.

8.7.2 **Operation.** The low-water cutoff shall automatically stop the combustion operation of the appliance when the water level drops below the lowest safe water level as established by the manufacturer.

SECTION 8.8
STEAM BLOWOFF VALVE

8.8.1 **General.** Every steam boiler shall be equipped with a quick-opening blowoff valve. The valve shall be installed in the opening provided on the boiler. The minimum size of the valve shall be the size specified by the boiler manufacturer or the size of the boiler blowoff-valve opening.

8.8.2 **Discharge.** Blow off valves shall discharge to a safe place of disposal. Where discharging to the drainage system, the installation shall conform to the *Saudi Building Code Sanitary Requirements*.

SECTION 8.9
HOT WATER BOILER EXPANSION TANK

8.9.1 **Where required.** An expansion tank shall be installed in every hot water system. For multiple boiler installations, a minimum of one expansion tank is required. Expansion tanks shall be of the closed or open type. Tanks shall be rated for the pressure of the hot water system.

8.9.2 **Closed-type expansion tanks.** Closed-type expansion tanks shall be installed in accordance with the manufacturer's instructions. The size of the tank shall be based on the capacity of the hot-water-heating system. The minimum size of the tank shall be determined in accordance with the following equation:

$$V_t = \frac{(0.000738T - 0.03348)V_s}{\left(\frac{P_a}{P_f}\right) - \left(\frac{P_a}{P_o}\right)}$$ **(Equation 8-1)**

Where:

V_t = Minimum volume of tanks (L).

V_s = Volume of system, not including expansion tanks (L).

T = Average operating temperature (^{o}C).

P_a = Atmospheric pressure (kPa).

P_f = Fill pressure (kPa).

P_o = Maximum operating pressure (kPa).

8.9.3 **Open-type expansion tanks.** Open-type expansion tanks shall be located a minimum of 120 cm above the highest heating element. The tank shall be adequately sized for the hot water system. An overflow with a minimum diameter of 25 mm shall be installed at the top of the tank. The overflow shall discharge to the drainage system in accordance with the *Saudi Building Code Sanitary Requirements*.

SECTION 8.10 GAUGES

8.10.1 **Hot water boiler gauges.** Every hot water boiler shall have a pressure gauge and a temperature gauge, or a combination pressure and temperature gauge. The gauges shall indicate the temperature and pressure within the normal range of the system's operation.

8.10.2 **Steam boiler gauges.** Every steam boiler shall have a water-gauge glass and a pressure gauge. The pressure gauge shall indicate the pressure within the normal range of the system's operation.

8.10.2.1 **Water-gauge glass.** The gauge glass shall be installed so that the midpoint is at the normal boiler water level.

SECTION 8.11 TESTS

8.11.1 **Tests.** Upon completion of the assembly and installation of boilers and pressure vessels, acceptance tests shall be conducted in accordance with the requirements of the ASME *Boiler and Pressure Vessel Requirements*. Where field assembly of pressure vessels or boilers is required, a copy of the completed U-1 Manufacturer's Data Report required by the ASME *Boiler and Pressure Vessel Requirements* shall be submitted to the code official.

8.11.2 **Test gauges.** An indicating test gauge shall be connected directly to the boiler or pressure vessel where it is visible to the operator throughout the duration of the test. The pressure gauge scale shall be graduated over a range of not less than one and one-half times and not greater than four times the maximum test pressure. All gauges utilized for testing shall be calibrated and certified by the test operator.

CHAPTER 9
REFRIGERATION

SECTION 9.1
GENERAL

9.1.1 **Scope**. This chapter governs the design, installation, construction and repair of refrigeration systems that vaporize and liquefy a fluid during the refrigerating cycle. Refrigerant piping design and installation, including pressure vessels and pressure relief devices, shall conform to these requirements. Permanently installed refrigerant storage systems and other components are considered as part of the refrigeration system to which they are attached.

9.1.2 **Factory-built equipment and appliances**. Listed and labeled self-contained, factory-built equipment and appliances shall be tested in accordance with (UL 207, 412, 471 or 1995). Such equipment and appliances are deemed to meet the design, manufacturing and factory test requirements of these requirements if installed in accordance with their listing and the manufacturer's installation instructions.

9.1.3 **Protection.** Any portion of a refrigeration system that is subject to physical damage shall be protected in an approved manner.

9.1.4 **Water connection**. Water supply and discharge connections associated with refrigeration systems shall be made in accordance with these requirements and the Saudi Plumbing Requirements.

9.1.5 **Fuel gas connection.** Fuel gas devices, equipment and appliances used with refrigeration systems shall be installed in accordance with the International Fuel Gas Requirements.

9.1.6 **General.** Refrigeration systems shall comply with the requirements of these requirements and, except as modified by these requirements, (ASHRAE 15). Ammonia-refrigerating systems shall comply with these requirements and, except as modified by these requirements, (ASHRAE 15) and (IIAR 2).

9.1.7 **Maintenance**. Mechanical refrigeration systems shall be maintained in proper operating condition, free from accumulations of oil, dirt, waste, excessive corrosion, other debris and leaks.

9.1.8 **Change in refrigerant type**. The type of refrigerant in refrigeration systems having a refrigerant circuit containing more than 100 kg of Group A1 or 13.6 kg of any other group refrigerant shall not be changed without prior notification to the code official and compliance with the applicable code provisions for the new refrigerant type.

9.1.9 **Refrigerant discharge**. Notification of refrigerant discharge shall be provided in accordance with the Saudi Fire Requirements.

SECTION 9.2
SYSTEM REQUIREMENTS

9.2.1 **General**. The system classification, allowable refrigerants, maximum quantity, enclosure requirements, location limitations, and field pressure test requirements shall be determined as follows:

1. Determine the refrigeration systems classification, in accordance with Section 9.3.3.
2. Determine the refrigerant classification in accordance with Section 9.3.1.
3. Determine the maximum allowable quantity of refrigerant in accordance with Section 9.4, based on type of refrigerant, system classification, and occupancy.
4. Determine the system enclosure requirements in accordance with Section 9.4.
5. Refrigeration equipment and appliance location and installation shall be subject to the limitations of Chapter 1.
6. Non-factory-tested, field-erected equipment and appliances shall be pressure tested in accordance with Section 9.8.

9.2.2 **Refrigerants**. The refrigerant shall be that which the equipment or appliance was designed to utilize or converted to utilize. Refrigerants not identified in Table 9.3.1 shall be approved before use.

9.2.2.1 **Mixing**. Refrigerants, including refrigerant blends, with different designations in (ASHRAE 34) shall not be mixed in a system.

Exception: Addition of a second refrigerant is allowed where permitted by the equipment or appliance manufacturer to improve oil return at low temperatures. The refrigerant and amount added shall be in accordance with the manufacturer's instructions.

9.2.2.2 **Purity.** Refrigerants used in refrigeration systems shall be new, recovered or reclaimed refrigerants in accordance with Section 9.2.2.2.1, 9.2.2.2.2 or 9.2.2.2.3. Where required by the equipment or appliance owner or the code official, the installer shall furnish a signed declaration that the refrigerant used meets the requirements of Section 9.2.2.2.1, 9.2.2.2.2 or 9.2.2.2.3.

Exception: The refrigerant used shall meet the purity specifications set by the manufacturer of the equipment or appliance in which such refrigerant is used where such specifications are different from that specified in Sections 9.2.2.2.1, 9.2.2.2.2 and 9.2.2.2.3.

9.2.2.2.1 **New refrigerants**. Refrigerants shall be of a purity level specified by the equipment or appliance manufacturer.

9.2.2.2.2 **Recovered refrigerants**. Refrigerants that are recovered from refrigeration and air-conditioning systems shall not be reused in other than the system from which they were recovered and in other systems of the same owner. Recovered refrigerants shall be filtered and dried before reuse. Recovered refrigerants that show clear signs of contamination shall not be reused unless reclaimed in accordance with Section 9.2.2.2.3.

9.2.2.2.3 **Reclaimed refrigerants.** Used refrigerants shall not be reused in a different owner's equipment or appliances unless tested and found to meet the purity requirements of (ARI 700). Contaminated refrigerants shall not be used unless reclaimed and found to meet the purity requirements of (ARI 700).

SECTION 9.3
REFRIGERATION SYSTEM CLASSIFICATION

9.3.1 **Refrigerant classification.** Refrigerants shall be classified in accordance with (ASHRAE 34) as listed in Table 9.3.1.

9.3.2 **Occupancy classification**. Locations of refrigerating systems are described by occupancy classifications that consider the ability of people to respond to potential exposure to refrigerants. Where equipment or appliances, other than piping, are located outside a building and within 6.0 m of any building opening, such equipment or appliances shall be governed by the occupancy classification of the building. Occupancy classifications shall be defined as follows:

1. Institutional occupancy is that portion of premises from which, because they are disabled, debilitated or confined, occupants cannot readily leave without the assistance of others. Institutional occupancies include, among others, hospitals, nursing homes, asylums and spaces containing locked cells.
2. Public assembly occupancy is that portion of premises where large numbers of people congregate and from which occupants cannot quickly vacate the space. Public assembly occupancies include, among others, auditoriums, wedding celebration halls, mosques, classrooms, passenger depots, restaurants and theaters.
3. Residential occupancy is that portion of premises that provides the occupants with complete independent living facilities, including permanent provisions for living, sleeping, eating, cooking and sanitation. Residential occupancies include, among others, dormitories, hotels, multiunit apartments and private residences.
4. Commercial occupancy is that portion of premises where people transact business, receive personal service or purchase food and other goods. Commercial occupancies include, among others, office and professional buildings, markets (but not large mercantile occupancies) and work or storage areas that do not qualify as industrial occupancies.
5. Large mercantile occupancy is that portion of premises where more than 100 persons congregate on levels above or below street level to purchase personal merchandise.
6. Industrial occupancy is that portion of premises that is not open to the public, where access by authorized persons is controlled, and that is used to manufacture, process or store goods such as chemicals, food, ice, meat or petroleum.
7. Mixed occupancy occurs when two or more occupancies are located within the same building. When each occupancy is isolated from the rest of the building by tight walls, floors and ceilings and by self-closing doors, the requirements for each occupancy shall apply to its portion of the building. When the various occupancies are not so isolated, the occupancy having the most stringent requirements shall be the governing occupancy.

9.3.3 **System classification.** Refrigeration systems are classified according to the degree of probability that refrigerant leaked from a failed connection, seal, or component could enter an occupied area. The distinction is based on the basic design or location of the components.

9.3.3.1 **Low-probability systems.** Double-indirect open-spray systems, indirect closed systems and indirect-vented closed systems shall be classified as low-probability systems, provided that all refrigerant-containing piping and fittings are isolated when the quantities in Table 9.3.1 are exceeded.

9.3.3.2 **High-probability systems.** Direct systems and indirect open-spray systems shall be classified as high-probability systems.

Exception: An indirect open-spray system shall not be required to be classified as a high-probability system if the pressure of the secondary coolant is at all times (operating and standby) greater than the pressure of the refrigerant.

SECTION 9.4
SYSTEM APPLICATION REQUIREMENTS

9.4.1 **General.** The refrigerant, occupancy and system classification cited in this section shall be determined in accordance with Sections 9.3.1, 9.3.2 and 9.3.3, respectively. For refrigerant blends assigned dual classifications, as formulated and for the worst case of fractionation, the classifications for the worst case of

fractionation shall be used.

9.4.2 **Machinery room.** Except as provided in Sections 9.4.2.1 and 9.4.2.2, all components containing the refrigerant shall be located either outdoors or in a machinery room where the quantity of refrigerant in an independent circuit of a system exceeds the amounts shown in Table 9.3.1. For refrigerant blends not listed in Table 9.3.1, the same requirements shall apply when the amount for any blend component exceeds that indicated in Table 9.3.1 for that component. These requirements shall also apply when the combined amount of the blend components exceeds a limit of 69,100 parts per million (ppm) by volume. Machinery rooms required by this section shall be constructed and maintained in accordance with Section 9.5 for Group A1 and B1 refrigerants and in accordance with Sections 9.5 and 9.6 for Group A2, B2, A3 and B3 refrigerants.

Exceptions:

1. Machinery rooms are not required for listed equipment and appliances containing not more than 3 kg of refrigerant, regardless of the refrigerant's safety classification, where installed in accordance with the equipment's or appliance's listing and the equipment or appliance manufacturer's installation instructions.
2. Piping in conformance with Section 9.7 is allowed in other locations to connect components installed in a machinery room with those installed outdoors.

Table 9.3.1
Refrigerant Classification, Amount and TLV-TWA

Refrigerant	Chemical Formula	Chemical Name or Blend	Hazard Categories[a]	Refrigerant Classification	Degrees of Hazard [b]	[M] Amount of Refrigeration per Occupied Space			
						Kg/30 cubic meter	ppm	g/m	TLV-TWA[f] (ppm)
R-11[e]	CCl_3F	Trichlorofluoromethane	OHH	A1	2-0-0[c]	0.19	1,100	6.2	C1,000
R-12[e]	CCl_2F_2	Dichlorodifluoromethane	CG,OHH	A1	2-0-0[c]	2.70	18,000	90	1,000
R-13[e]	$CClF_3$	Chlorotrifluoromethane	CG,OHH	A1	2-0-0[c]	8.66	67,000	290	1,000
R-13B1[e]	$CBrF_3$	Bromotrifluoromethane	CG,OHH	A1	2-0-0[c]	10.58	57,000	350	1,000
R-14	CF_4	Tetrafluoromethane (carbon tetrafluoride)	CG,OHH	A1	2-0-0[c]	7.70	69,000	250	1,000
R-22	$CHClF_2$	Chlorodifluoromethane	CG,OHH	A1	2-0-0[c]	2.65	25,000	89	1,000
R-23	CHF_3	Trifluoromethane (fluoroform)	CG,OHH	A1	2-0-0[c]	3.51	41,000	120	1,000
R-32	CH_2, F_2	Difluoromethane (methylene fluoride)	CG,F,OHH	A2		2.02	32,000	68	-----
R-113[e]	CCl_2FCClF 2	1, 1,2-trichloro-1,2,2-trifluoroethane	OHH	A1	2-0-0[c]	0.58	2,600	20	1,000
R-114[e]	CClF2CCl F_2	1,2-dichloro-1,2,2-tetrafluoroethane	CG,OHH	A1	2-0-0[c]	4.18	20,000	140	1,000
R-116	CF_3CF_3	Hexafluoroethane	CH,OHH	A1	1-0-0	11.54	69,000	390	-----
R-123	$CHCl_2CF_3$	2,2-dichloro-1,1,1-trifluoroethane	OHH	B1	2-0-0[c]	1.68	9,100	57	50
R-124	$CHClFCF_3$	2-chloro-1,1,1,2-tetrafluoroethane	CG,OHH	A1	2-0-0[c]	1.68	10,000	56	1,000
R-125	CHF_2CF_3	Pentafluoroethane	CG,OHH	A1	2-0-0[c]	10.10	69,000	340	-----
R-134[a]	CH_2FCF_3	1,1,1,2-tetrafluoroethane	CG,OHH	A1	2-0-0[c]	6.25	50,000	210	1,000
R-143[a]	CH_3CF_3	1,1,1-trifluoroethane	CG,F,OHH	A2	2-0-0[c]	1.83	18,000	60	-----
R-152[a]	CH_3CHF_2	1,1-difluorethane	CG,F,OHH	A2	1-4-0	0.77	9,300	25	-----
R-170	CH_3CH_3	Ethane	CG,F,OHH	A3	2-4-0	0.26	7,000	8.7	1,000
R-218	$CF_3CF_2CF_3$	Octafluoropropane	CG,OHH	A1	2-0-0[c]	15.87	69,000	530	-----

(continued)

Table 9.3.1 (continued)
Refrigerant Classification, Amount and TLV-TWA

Refrigerant	Chemical Formula	Chemical Name or Blend	Hazard Categories[a]	Refrigerant Classification	Degrees of Hazard [b]	[M] Amount of Refrigeration per Occupied Space			
						Kg/30 cubic meter	ppm	g/m	TLV-TWA[f] (ppm)
R-236fa	CF_3,CH_2CF_3	1,1,1,3,3,3-hexafluoropropane	CG,OHH	A1	2-0-0[c]	10.10	55,000	-----	1,000
R-245fa	CHF_2,CH_2,CF_3	1,1,1,3,3-pentafluoropropane	CG,OHH	B1	2-0-0[c]	5.77	34,000	-----	300
R-290	$CH_3CH_2CH_3$	Propane	CG,F,OHH	A3	2-4-0	0.27	5,000	9.0	2,500
R400[e]	zeotrope	R-12/114	CG,OHH	A1	2-0-0[c]	4.47	26,000	150	-----
R-401A	zeotrope	R-22/152a/124 (53/13/34)	CG,OHH	A1	2-0-0[c]	2.31	20,000	77	-----
R-401B	zeotrope	R-22/152a/124 (61/11/28)	CG,OHH	A1	2-0-0[c]	2.36	21,000	79	-----
R-401C	zeotrope	R-22/152a/124 (33/15/52)	CG,OHH	A1	2-0-0[c]	2.12	17,000	71	-----
R-402A	zeotrope	R-125/290/22 (60/2/38)	CG,OHH	A1	2-0-0[c]	4.81	39,000	160	-----
R-402B	zeotrope	R-125/290/22 (38/2/60)	CG,OHH	A1	2-0-0[c]	3.75	32,000	120	-----
R-403A	zeotrope	R-290/22/218 (5/75/20)	CG,OHH	A1	2-0-0[c]	-----	-----	-----	-----
R-403B	zeotrope	R-290/22/218 (5/56/39)	CG,OHH	A1	2-0-0[c]	-----	-----	-----	-----
R-404A	zeotrope	R-125/143a/134a (44/52/4)	CG,OHH	A1	2-0-0[c]	8.18	69,000	280	69,000
R-406A	zeotrope	R-22/600a/142b (55/4/41)	CGF,OHH	A1	-----	-----	-----	-----	-----
R-407A	zeotrope	R-32/125/134a (20/40/40)	CG,OHH	A1	2-0-0[c]	7.70	69,000	260	-----
R-407B	zeotrope	R-32/125/134a (10/70/20)	CG,OHH	A1	2-0-0[c]	8.66	69,000	290	-----
R-407C	zeotrope	R-32/125/134a (23/25/52)	CG,OHH	A1	2-0-0[c]	7.21	69,000	240	-----
R-407D	zeotrope	R-32/125/134a (15/15/70)	CG,OHH	A1	2-0-0[c]	7.21	65,000	240	-----
R-407E	zeotrope	R-32/125/134a (25/15/60)	CG,OHH	A1	2-0-0[c]	7.21	69,000	240	-----
R-408A	zeotrope	R-125/143a/22 (7/46/47)	CG,OHH	A1	2-0-0[c]	4.80	47,000	170	-----
R-409A	zeotrope	R-22/124/142b (60/25/15)	CG,OHH	A1	2-0-0[c]	2.36	20,000	79	-----
R-409B	zeotrope	R-22/124/142b (65/25/10)	CG,OHH	A1	2-0-0[c]	2.36	20,000	78	-----
R410A	zeotrope	R-32/125 (50/50)	CG,OHH	A1	2-0-0[c]	4.81	55,000	160	-----
R-410B	zeotrope	R-32/125 (45/55)	CG,OHH	A1	2-0-0[c]	5.29	58,000	180	-----
R-411A	zeotrope	R-127/22/152a (1.5/87.5/11.0)	CG,F,OHH	A2	-----	-----	-----	-----	-----
R-411B	zeotrope	R-1270/22/152a (3/94/3)	CG,F,OHH	A2	-----	-----	-----	-----	-----
R-412A	zeotrope	R-22/318/142b (70/5/25)	CG,F,OHH	A2	-----	-----	-----	-----	-----
R-413A	zeotrope	R-218/134a/600a (9/88/3)	CG,F,OHH	A2	-----	-----	-----	-----	-----
R-414A	zeotrope	R-22/124/600a/142b (51/28.5/4/16.5)	CG,OHH	A1	-----	-----	-----	-----	-----
R-414B	zeotrope	R-22/124/600a/142b (50/39/1.5/9.5)	CG,OHH	A1	-----	-----	-----	-----	-----
R-416A	zeotrope	R-134a/124/600 (59/39.5/1.5)	CG,OHH	A1	2-0-0[c]	2.89	21,000	96	-----
R-417A	zeotrope	R-125/134a/600 (45.5/50/3.5)	CG,OHH	A1	2-0-0[c]	-----	-----	-----	-----
R-500[e]	azeotrope	R-12/152a (73.8/26.2)	CG,OHH	A1	2-0-0[c]	3.56	29,000	120	1,000
R-502[e]	azeotrope	R-22/115 (48.8/51.2)	CG,OHH	A1	2-0-0[c]	4.81	35,000	160	1,000
R-503[e]	azeotrope	R-23/13 (40.1/59.9)	CG,OHH	A1	2-0-0[c]	7.21	67,000	240	1,000
R-507A	azeotrope	R-125/143a (50/50)	CG,OHH	A1	2-0-0[c]	8.18	69,000	280	-----
R-508A	azeotrope	R-23/116 (39/61)	CG,OHH	A1	2-0-0[c]	6.73	55,000	220	-----
R-508B	azeotrope	R-23/116 (46/54)	CG,OHH	A1	2-0-0[c]	6.25	52,000	200	-----
R-509A	zeotrope	R-22/218 (44/56)	CG,OHH	A1	2-0-0[c]	5.77	38,000	190	-----
R-600	$CH_3CH_2CH_2CH_3$	Butane	CG,F,OHH	A3	1-4-0	-----	-----	-----	-----
R-600a	$CH(CH_3)$2-CH_3	Isobutane (2-methyl propane)	CG,F,OHH	A3	2-4-0	0.25	2,500	6.0	800
R-717	NH3	Ammonia	CG,C,F,OHH	B2	3-3-0[d]	0.011	500	0.35	25
R-718	H2O	Water	-----	A1	0-0-0	-----	-----	-----	-----
R-744	CO2	Carbon dioxide	CG,OHH	A1	2-0-0[c]	2.16	40,000	72	5,000
R-1150	CH2=CH2	Ethene (ethylene)	CG,F,OHH	A3	1-4-2	0.18	5,200	6.0	1,000
R-1270	CH3CH=CH2	Propene (propylene)	CG,F,OHH	B3	1-4-1	0.18	3,400	5.0	660

a. CG = Compressed gas; C = Corrosive; F = Flammable; OHH = Other Health Hazard.
b. Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.
c. Reduction to 1-0-0 is allowed if analysis satisfactory to the code official shows that the maximum concentration for a rupture or full loss of refrigerant charge would not exceed the IDLH, considering both the refrigerant quantity and room volume.
d. For installations that are entirely outdoors, use 3-1-0.
e. Class I ozone depleting substance; prohibited for new installations.
f. PEL or consistent occupational exposure limit on a time-weighted average (TWA) basis (unless noted C for ceiling) for an 8 hr/d and 40 hr/wk.

9.4.2.1 **Institutional occupancies.** The amounts shown in Table 9.3.1 shall be reduced by 50 percent for all areas of institutional occupancies except kitchens, laboratories, and mortuaries. The total of all Group A2, B2, A3 and B3 refrigerants shall not exceed 250 kg in occupied areas or machinery rooms.

9.4.2.2 **Industrial occupancies and refrigerated rooms.** This section applies only to industrial occupancies and refrigerated rooms for manufacturing, food and beverage preparation, meat cutting, other processes and storage. Machinery rooms are not required where all of the following conditions are met:

1. The space containing the machinery is separated from other occupancies by tight construction with tight-fitting doors.
2. Access is restricted to authorized personnel.
3. The floor area per occupant is not less than 9.3 m^2 where machinery is located on floor levels with exits more than 2 m above the ground. Where provided with egress directly to the outdoors or into approved building exits, the minimum floor area shall not apply.
4. Refrigerant detectors are installed as required for machinery rooms in accordance with Section 9.5.3.
5. Surfaces having temperatures exceeding 425°C and open flames are not present where any Group A2, B2, A3 or B3 refrigerant is used (see Section 9.4.3.4).
6. All electrical equipment and appliances conform to Class 1, Division 2, hazardous location classification requirements of (NFPA 70) where the quantity of any Group A2, B2, A3 or B3 refrigerant in a single independent circuit would exceed 25 percent of the lower flammability limit (LFL) upon release to the space.
7. All refrigerant-containing parts in systems exceeding 74.6 kW drive power, except evaporators used for refrigeration or dehumidification; condensers used for heating; control and pressure relief valves for either; and connecting piping, shall be located either outdoors or in a machinery room.

9.4.3 **Refrigerant restrictions**. Refrigerant applications, maximum quantities and use shall be restricted in accordance with Sections 9.4.3.1 through 9.4.3.4.

9.4.3.1 **Air-conditioning for human comfort**. In other than industrial occupancies where the quantity in a single independent circuit does not exceed the amount in Table 9.3.1, Group B1, B2 and B3 refrigerants shall not be used in high-probability systems for air-conditioning for human comfort.

9.4.3.2 **Non-industrial occupancies**. Group A2 and B2 refrigerants shall not be used in high-probability systems where the quantity of refrigerant in any independent refrigerant circuit exceeds the amount shown in Table 9.4.3.2. Group A3 and B3 refrigerants shall not be used except where approved.

Exception: This section does not apply to laboratories where the floor area per occupant is not less than 9.3 m^2.

9.4.3.3 **All occupancies**. The total of all Group A2, B2, A3 and B3 refrigerants other than R-717, ammonia, shall not exceed 500 kg except where approved.

9.4.3.4 **Protection from refrigerant decomposition**. Where any device having an open flame or surface temperature greater than 425°C is used in a room containing more than 3 kg of refrigerant in a single independent circuit, a hood and exhaust system shall be provided in accordance with Section 3.10. Such exhaust system shall exhaust combustion products to the outdoors.

Exception: A hood and exhaust system shall not be required:

1. Where the refrigerant is R-717, R-718, or R-744;
2. Where the combustion air is ducted from the outdoors in a manner that prevents leaked refrigerant from being combusted; or

3. Where a refrigerant detector is used to stop the combustion in the event of a refrigerant leak (see Sections 9.5.3 and 9.5.5).

Table 9.4.3.2
Maximum Permissible Quantities of Refrigerants

Type of Refrigeration System	Maximum Kg for Various Occupancies			
	Institutional	Assembly	Residential	All other occupancies
Sealed absorption system				
In exit access	0	0	1.5	1.5
In adjacent outdoor locations	0	0	10	10
In other than exit access	0	3	3	3
Unit systems				
In other than exit access	0	0	3	3

9.4.4 **Volume calculations**. Volume calculations shall be in accordance with Sections 9.4.4.1 through 9.4.4.3.

9.4.4.1 **Non-communicating spaces**. Where the refrigerant-containing parts of a system are located in one or more spaces that do not communicate through permanent openings or HVAC ducts, the volume of the smallest, enclosed occupied space shall be used to determine the permissible quantity of refrigerant in the system.

9.4.4.2 **Communicating spaces.** Where an evaporator or condenser is located in an air duct system, the volume of the smallest, enclosed occupied space served by the duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

Exception: If airflow to any enclosed space cannot be reduced below one-quarter of its maximum, the entire space served by the air duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

9.4.4.3 **Plenums**. Where the space above a suspended ceiling is continuous and part of the supply or return air plenum system, this space shall be included in calculating the volume of the enclosed space.

SECTION 9.5
MACHINERY ROOM, GENERAL REQUIREMENTS

9.5.1 **Design and construction**. Machinery rooms shall be designed and constructed in accordance with the *Saudi Building Code* and this section.

9.5.2 **Openings**. Ducts and air handlers in the machinery room that operate at a lower pressure than the room shall be sealed to prevent any refrigerant leakage from entering the air stream.

9.5.3 **Refrigerant detector.** Refrigerant detectors in machinery rooms shall be provided as required by the *Saudi Fire Requirement*s.

9.5.4 **Tests.** Periodic tests of the mechanical ventilating system shall be performed in accordance with manufacturer's specifications and as required by the code official.

9.5.5 **Fuel-burning appliances**. Open flames that use combustion air from the machinery room shall not be installed in a machinery room.

Exceptions:

1. Matches, lighters, leak detectors and similar devices.
2. Where the refrigerant is carbon dioxide or water.

3. Fuel-burning appliances shall not be prohibited in the same machinery room with refrigerant-containing equipment or appliances where combustion air is ducted from outside the machinery room and sealed in such a manner as to prevent any refrigerant leakage from entering the combustion chamber, or where a refrigerant vapor detector is employed to automatically shutoff the combustion process in the event of refrigerant leakage.

9.5.6 **Ventilation.** Machinery rooms shall be mechanically ventilated to the outdoors. Mechanical ventilation shall be capable of exhausting the minimum quantity of air both at normal operating and emergency conditions. Multiple fans or multi-speed fans shall be allowed in order to produce the emergency ventilation rate and to obtain a reduced airflow for normal ventilation.

Exception: Where a refrigerating system is located outdoors more than 6.0 m from any building opening and is enclosed by a penthouse, lean to or other open structure, natural or mechanical ventilation shall be provided. Location of the openings shall be based on the relative density of the refrigerant to air. The free-aperture cross section for the ventilation of the machinery room shall be not less than:

$$F = 0.138\sqrt{G} \qquad \textbf{(Equation 9-1)}$$

Where:

F = The free opening area in m^2.

G = The mass of refrigerant in kg in the largest system, any part of which is located in the machinery room.

9.5.6.1 **Discharge location**. The discharge of the air shall be to the outdoors in accordance with Chapter 3. Exhaust from mechanical ventilation systems shall be discharged not less than 6.0 m from a property line or openings into buildings.

9.5.6.2 **Make-up air.** Provisions shall be made for make-up air to replace that being exhausted. Openings for make-up air shall be located to avoid intake of exhaust air. Supply and exhaust ducts to the machinery room shall serve no other area, shall be constructed in accordance with Chapter 3 and shall be covered with corrosion-resistant screen of not less than 6.5 mm mesh.

9.5.6.3 **Quantity-normal ventilation**. During occupied conditions, the mechanical ventilation system shall exhaust the larger of the following:

1. Not less than 0.0025 $m^3/s\ m^2$ of machinery room area or 0.01 m^3/s per person; or
2. A volume required to limit the room temperature rise to 10°C taking into account the ambient heating effect of all machinery in the room.

9.5.6.4 **Quantity-emergency conditions**. Upon actuation of the refrigerant detector required in Section 9.5.3, the mechanical ventilation system shall exhaust air from the machinery room in the following quantity:

$$Q = 0.07\sqrt{G} \qquad \textbf{(Equation 9-2)}$$

Where:

Q = The airflow in m^3/s.

G = The design mass of refrigerant in kg in the largest system, any part of which is located in the machinery room.

9.5.7 **Termination of relief devices**. Pressure relief devices, fusible plugs and purge systems located within the machinery room shall terminate outside of the structure at a location not less than 4.6 m above the adjoining grade level and not less than 6.0 m from any window, ventilation opening or exit.

9.5.8 **Ammonia discharge.** Pressure relief valves for ammonia systems shall discharge in accordance with (ASHRAE 15).

SECTION 9.6
MACHINERY ROOM, SPECIAL REQUIREMENTS

9.6.1 **General.** Where required by Section 9.4.2, the machinery room shall meet the requirements of this section in addition to the requirements of Section 9.5.

9.6.2 **Elevated temperature.** There shall not be an open flame-producing device or continuously operating hot surface over 425°C permanently installed in the room.

9.6.3 **Ammonia room ventilation.** Ventilation systems in ammonia machinery rooms shall be operated continuously.

Exceptions:

1. Machinery rooms equipped with a vapor detector that will automatically start the ventilation system and actuate an alarm at a detection level not to exceed 1,000 ppm; or
2. Machinery rooms conforming to the Class 1, Division 2, hazardous location classification requirements of (NFPA 70).

9.6.4 **Flammable refrigerants**. Where refrigerants of Groups A2, A3, B2 and B3 are used, the machinery room shall conform to the Class 1, Division 2, hazardous location classification requirements of (NFPA 70).

Exception: Ammonia machinery rooms.

9.6.5 **Remote controls**. Remote control of the mechanical equipment and appliances located in the machinery room shall be provided as required by the Saudi Fire Requirements.

9.6.5.1 **Refrigeration system.** A clearly identified switch of the break-glass type shall provide off-only control of all electrically energized equipment and appliances in the machinery room, other than refrigerant leak detectors and machinery room ventilation.

9.6.5.2 **Ventilation system.** A clearly identified switch of the break-glass type shall provide on-only control of the machinery room ventilation fans.

9.6.6 **Emergency signs and labels**. Refrigeration units and systems shall be provided with approved emergency signs, charts, and labels in accordance with the Saudi Fire Requirements.

SECTION 9.7
REFRIGERANT PIPING

9.7.1 **General.** All refrigerant piping shall be installed, tested and placed in operation in accordance with this chapter.

9.7.2 **Pipe enclosures.** Rigid or flexible metal enclosures or pipe ducts shall be provided for soft, annealed copper tubing and used for refrigerant piping erected on the premises and containing other than Group A1 or B1 refrigerants. Enclosures shall not be required for connections between condensing units and the nearest riser box(es), provided such connections do not exceed 1.8 m in length.

9.7.3 **Condensation.** All refrigerating piping and fittings, brine piping and fittings that, during normal operation, will reach a surface temperature below the dew point of the surrounding air, and are located in spaces or areas where condensation will cause a safety hazard to the building occupants, structure, electrical equipment or any other equipment or appliances, shall be protected in an approved manner to prevent such damage.

9.7.4 **Materials for refrigerant pipe and tubing.** Piping materials shall be as set forth in Sections 9.7.4.1 through 9.7.4.5.

9.7.4.1 **Steel pipes** Carbon steel pipe with a wall thickness not less than Schedule 80 shall be used for Group A2, A3, B2 or B3 refrigerant liquid lines for sizes 35 mm and smaller. Carbon steel pipe with a wall thickness not less than Schedule 40 shall be used for Group A1 or B1 refrigerant liquid lines 150 mm and smaller, Group A2, A3, B2 or B3 refrigerant liquid lines sizes 50 mm through 150 mm and all refrigerant suction and discharge lines 150 mm and smaller. Type F steel pipe shall not be used for refrigerant lines having an operating temperature less than -29°C.

9.7.4.2 **Copper and brass pipe.** Standard iron-pipe size, copper and red brass (not less than 80-percent copper) pipe shall conform to (ASTM B 42 and 43).

9.7.4.3 **Copper tube.** Copper tube used for refrigerant piping erected on the premises shall be seamless copper tube of Type ACR (hard or annealed) complying with (ASTM B 280). Where approved, copper tube for refrigerant piping erected on the premises shall be seamless copper tube of Type K, L or M (drawn or annealed) in accordance with (ASTM B 88). Annealed temper copper tube shall not be used in sizes larger than a 50 mm nominal size. Mechanical joints shall not be used on annealed temper copper tube in sizes larger than 22 mm OD size.

9.7.4.4 **Copper tubing joints.** Copper tubing joints used in refrigerating systems containing Group A2, A3, B2 or B3 refrigerants shall be brazed. Soldered joints shall not be used in such refrigerating systems.

9.7.4.5 **Aluminum tube.** Type 3003-0 aluminum tubing with high-pressure fittings shall not be used with methyl chloride and other refrigerants known to attack aluminum.

9.7.5 **Joints and refrigerant-containing parts in air ducts.** Joints and all refrigerant-containing parts of a refrigerating system located in an air duct of an air-conditioning system carrying conditioned air to and from human-occupied space shall be constructed to withstand, without leakage, a pressure of 150 percent of the higher of the design pressure or pressure relief device setting.

9.7.6 **Exposure of refrigerant pipe joints.** Refrigerant pipe joints erected on the premises shall be exposed for visual inspection prior to being covered or enclosed.

9.7.7 **Stop valves.** All systems containing more than 3 kg of a refrigerant in systems using positive-displacement compressors shall have stop valves installed as follows:

1. At the inlet of each compressor, compressor unit or condensing unit.
2. At the discharge outlet of each compressor, compressor unit or condensing unit and of each liquid receiver.

Exceptions:

1. Systems that have a refrigerant pump out function capable of storing the entire refrigerant charge in a receiver or heat exchanger.
2. Systems that are equipped with provisions for pump out of the refrigerant using either portable or permanently installed recovery equipment.
3. Self-contained systems.

9.7.7.1 **Liquid receivers.** All systems containing 45 kg or more of a refrigerant, other than systems utilizing non-positive displacement compressors, shall have stop valves, in addition to those required by Section 9.7.7, on each inlet of each liquid receiver. Stop valves shall not be required on the inlet of a receiver in a condensing unit, nor on the inlet of a receiver, which is an integral part of the condenser.

9.7.7.2 **Copper tubing.** Stop valves used with soft annealed copper tubing or hard-drawn copper tubing 22 mm OD standard size or smaller shall be securely mounted, independent of tubing fastenings or supports.

9.7.7.3 **Identification.** Stop valves shall be identified where their intended purpose is not obvious. Numbers shall not be used to label the valves, unless a key to the numbers is located near the valves.

9.7.8 **Insulation.** Refrigerant direct expansion split system suction from evaporator to compressor shall be insulated by an approved means.

9.7.8.1 **Insulation protection**. Piping insulation shall be protected from mechanical damage by a suitable and acceptable means. This may include cladding or the use of pre-jacketed insulated piping.

9.7.8.2 **Insulation installed outdoors**. In addition to the requirements of 9.7.8.1 if insulated refrigerant piping is installed outdoors the piping shall be protected from moisture and sunlight degradation by an approved and acceptable method.

9.7.9 **Refrigerant piping temperature-sensing bulb**. Evaporator coil Temperature-Sensing Bulb (TSB) mounting shall be on the refrigerant suction line downstream of the evaporator. The TSB shall be tightly strapped and secured to the suction line and insulated from surrounding airflow. The location of the TSB is as follows:

1. For horizontal suction lines the TSB shall be mounted approximately at the 4 o'clock or 8 o'clock positions.
2. For vertical suction lines the TSB shall be mounted so that the TSB's pressure transmitting tubes emerge from the top of the TSB.

9.7.10 **Crankcase heater.** A crankcase oil heater shall be provided for all compressors of 5 tons and larger. The crankcase oil heater shall be installed by the manufacturer during compressor manufacturing.

9.7.11 **Filter-Driers.** For 10 tons refrigeration capacity and larger, replaceable-core filter-driers shall be located on the liquid line of a direct expansion refrigeration system ahead of the metering or expansion valve. Isolation valves shall be installed immediately upstream and downstream of the filter-drier. If a by-pass line is provided around the filter-drier an additional and equivalent standby filter-drier shall be located on this by-pass line.

SECTION 9.8
FIELD TEST

9.8.1 **General.** Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, vessels, evaporators, safety devices, pressure gauges and control mechanisms that are listed and factory tested, shall be tested and proved tight after complete installation, and before operation. Tests shall include both the high- and low-pressure sides of each system at not less than the lower of the design pressures or the setting of the pressure relief device(s). The design pressures for testing shall be those listed on the condensing unit, compressor or compressor unit nameplate, as required by (ASHRAE 15).

Exceptions:

1. Gas bulk storage tanks that are not permanently connected to a refrigeration system.
2. Systems erected on the premises with copper tubing not exceeding 15.8 mm OD, with wall thickness as required by (ASHRAE 15), shall be tested in accordance with Section 9.8.1, or by means of refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 21°C or higher.
3. Limited-charge systems equipped with a pressure relief device, erected on the premises, shall be tested at a pressure not less than one and one-half times the pressure setting of the relief device. If the equipment or appliance has been tested by the manufacturer at one and one-half times the design pressure, the test after erection on the premises shall be conducted at the design pressure.

9.8.1.1 **Booster compressor.** Where a compressor is used as a booster to obtain an intermediate pressure and discharges into the suction side of another compressor, the booster compressor shall be considered a part of the low side, provided that it is protected by a pressure relief device.

9.8.1.2 **Centrifugal/non-positive displacement compressors.** In field-testing systems using centrifugal or other non-positive displacement compressors, the entire system shall be considered as the low-side pressure for field test purposes.

9.8.2 **Test gases.** Tests shall be performed with an inert dried gas including, but not limited to, nitrogen and carbon dioxide. Oxygen, air, combustible gases and mixtures containing such gases shall not be used.

Exception: The use of air is allowed to test R-717 (ammonia) systems provided that they are subsequently evacuated before charging with refrigerant.

9.8.3 **Test apparatus**. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gauge on the outlet side.

9.8.4 **Declaration**. A certificate of test shall be provided for all systems containing 25 kg or more of refrigerant. The certificate shall give the name of the refrigerant and the field test pressure applied to the high side and the low side of the system. The certification of test shall be signed by the installer and shall be made part of the public record.

9.8.5 **Leak Testing.** All refrigerant field charged equipment and piping shall be leak tested prior to painting, insulation or burial. Leak tests shall be performed in accordance to ASHRAE Refrigeration Handbook.

SECTION 9.9
PERIODIC TESTING

9.9.1 **Testing required.** The following emergency devices and systems shall be periodically tested in accordance with the manufacturer's instructions and as required by the code official:

1. Treatment and flaring systems.
2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes.
3. Fans and associated equipment intended to operate emergency pure ventilation systems.
4. Detection and alarm systems.

CHAPTER 10
HYDRONIC PIPING

SECTION 10.1
GENERAL

10.1.1 **Scope.** The provisions of this chapter shall govern the construction, installation, alteration and repair of hydronic piping systems. This chapter shall apply to hydronic piping systems that are part of heating, ventilation and air-conditioning systems. Such piping systems shall include steam, hot water, chilled water, steam condensate and ground source heat pump loop systems. Potable cold and hot water distribution systems shall be installed in accordance with the *Saudi Plumbing Requirement*s.

10.1.2 **Pipe sizing.** Piping for hydronic systems shall be sized for the demand of the system.

SECTION 10.2
MATERIAL

10.2.1 **Piping.** Piping material shall conform to the standards cited in this section.
Exception: Embedded piping regulated by Section 10.9.

10.2.1.1 **Plastic piping schedule.** Plastic piping (i.e.: PVC, CPVC, ABS, PB and PE) shall be of Class 5 or greater.
Exception: Use of compatible Schedule 80 piping may be used in lieu of Class 5. Special care is required when tying a metric based piping system to a customary unit piping system.

10.2.1.2 **PVC temperature rating.** PVC piping and fittings shall not be used for water temperatures above 48^{o}C.

10.2.1.3 **CPVC temperature rating.** CPVC piping and fittings shall not be used for water temperatures above 70^{o}C.

10.2.1.4 **Plastic piping and fittings temperature rating.** For plastic piping and fittings other than PVC and CPVC listed in paragraphs 10.1.2.2 and 10.1.2.3 above the allowable temperature ratings (both minimum and maximum) shall be as per corresponding manufacturer limitations.

10.2.2 **Used materials.** Reused pipe, fittings, valves or other materials shall be clean and free of foreign materials and shall be approved by the code official for reuse.

10.2.3 **Material rating.** Materials shall be rated for the operating temperature and pressure of the hydronic system. Materials shall be suitable for the type of fluid in the hydronic system.

10.2.4 **Piping materials standards.** Hydronic pipe shall conform to the standards listed in Table 10.2.4. The exterior of the pipe shall be protected from corrosion and degradation.

Table 10.2.4
Hydronic Pipe

Material	Standard
Acrylonitrile butadiene styrene (ABS) plastic pipe	(ASTM D 1527); (ASTM D 2282)
Brass pipe	(ASTM B 43)
Brass tubing	(ASTM B 135)
Copper or copper-alloy pipe	(ASTM B 42); (ASTM B 302)
Copper or copper-alloy tube (Type K, L or M)	(ASTM B 75); (ASTM B 88); (ASTM B 251)
Chlorinated polyvinyl chloride (CPVC) plastic pipe	(ASTM D 2846); (ASTM F 441); (ASTM F 442)
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe	(ASTM F 1281); (CSA CAN/CSA-B-137.10)
Cross-linked polyethylene (PEX) tubing	(ASTM F 876); (ASTM F 877)
Polybutylene (PB) plastic pipe and tubing	(ASTM D 3309)
Polyethylene (PE) pipe, tubing and fittings (for ground source heat pump loop systems)	(ASTM D 2513); (ASTM D 3035); (ASTM D 2447); (ASTM D 2683); (ASTM F 1055) ; (ASTM D 2837); (ASTM D 3350); (ASTM D 1693)
Polyvinyl chloride (PVC) plastic pipe	(ASTM D 1785); (ASTM D 2241)
Steel pipe	(ASTM A 53); (ASTM A 106)
Steel tubing	(ASTM A 254)
Reinforced Thermo-Resin (RTR) pipe	(ASTM D2412, D2563, D2925, D2992, D2996, D4024); (AWWA C206, C950-01)

10.2.5 **Pipe fittings.** Hydronic pipe fittings shall be approved for installation with the piping materials to be installed, and shall conform to the respective pipe standards or to the standards listed in Table 10.2.5.

10.2.5.1 **Maximum allowable velocity in piping.** Maximum allowable velocity in piping shall be 2.3 m/s for all piping material and fittings except copper and brass valves.

10.2.5.2 **Maximum allowable velocity in copper and brass valves.** Maximum allowable velocity in copper and brass valves shall not exceed 1.2 m/s.

Table 10.2.5
Hydronic Pipe Fittings

Material	Standard
Bronze	(ASME B16.24)
Copper and copper alloys	(ASME B16.15); (ASME B16.18); (ASME B16.22); (ASME B16.23); (ASME B16.26; (ASME B16.29)
Gray iron	(ASTM A 126)
Malleable iron	(ASME B16.3)
Plastic	(ASTM D 2466); (ASTM D 2467); (ASTM D 2468); (ASTM F 438); (ASTM F 439); (ASTM F 877)
Steel	(ASME B16.5); (ASME B16.9); (ASME B16.11); (ASME B16.28); (ASTM A 420)
Brass	(ASTM F 1974)
Reinforced Thermo-Resin (RTR) pipe fittings	(ASTM D2412), (D2563, D2925, D2992, D2996, D4024); (AWWA C206, C950-01)

10.2.6 **Valves.** Valves shall be constructed of materials that are compatible with the type of piping material and fluids in the system. Valves shall be rated for the temperatures and pressures of the systems in which the valves are installed.

10.2.7 **Flexible connectors, expansion and vibration compensators.** Flexible connectors, expansion and vibration control devices and fittings shall be of an approved type.

SECTION 10.3
JOINTS AND CONNECTIONS

10.3.1 **Approval.** Joints and connections shall be of an approved type. Joints and connections shall be tight for the pressure of the hydronic system.

10.3.1.1 **Joints between different piping materials.** Joints between different piping materials shall be made with approved adapter fittings. Joints between different metallic piping materials shall be made with approved dielectric fittings or brass converter fittings.

10.3.2 **Preparation of pipe ends.** Pipe shall be cut square, reamed and chamfered, and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

10.3.3 **Joint preparation and installation.** When required by Sections 10.3.4 through 10.3.14, the preparation and installation of brazed, mechanical, soldered, solvent-cemented, threaded and welded joints shall comply with Sections 10.3.3.1 through 10.3.3.7.

10.3.3.1 **Brazed joints.** Joint surfaces shall be cleaned. An approved flux shall be applied where required. Joints shall be joined without delay after applying flux. The joint shall be brazed with a filler metal conforming to (AWS A5.8).

10.3.3.2 **Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

10.3.3.3 **Soldered joints.** Joint surfaces shall be cleaned. A flux conforming to (ASTM B 813) shall be applied. The joint shall be soldered with a solder conforming to (ASTM B 32).

10.3.3.4 **Solvent-cemented joints.** Joint surfaces shall be clean and free of moisture. An approved primer shall be applied to CPVC and PVC pipe-joint surfaces. Joints shall be made while the cement is wet. Solvent cement conforming to the following standards shall be applied to all joint surfaces:

1. (ASTM D 2235) for ABS joints.
2. (ASTM F 493) for CPVC joints.
3. (ASTM D 2564) for PVC joints.

CPVC joints shall be made in accordance with (ASTM D 2846).

10.3.3.4.1 **Solvent cements.** In addition to the above solvent cements, primers and cleaning solutions shall comply with the following:

1. Containers of solvent cements, primers and cleaning solutions shall have the date of manufacture on the label.
2. Solvent cements shall not be used past the Manufacturer's expiry dates shown on the label, or one year past the date of manufacture if no expiry date is specified.
3. Solvent cements shall be stored in approved air-conditioned areas.

10.3.3.5 **Threaded joints.** Threads shall conform to (ASME B1.20.1). Schedule 80 or heavier plastic pipe shall be threaded with dies specifically designed for plastic

pipe. Thread lubricant, pipe-joint compound or tape shall be applied on the male threads only and shall be approved for application on the piping material.

10.3.3.6 **Welded joints.** Joint surfaces shall be cleaned by an approved procedure. Joints shall be welded with an approved filler metal.

10.3.3.7 **Grooved and shouldered joints.** Grooved and shouldered joints shall be approved and installed in accordance with the manufacturer's installation instructions.

10.3.3.8 **Mechanically formed tee fittings.** Mechanically extracted outlets shall have a height not less than three times the thickness of the branch tube wall.

10.3.3.8.1 **Full flow assurance.** Branch tubes shall not restrict the flow in the run tube. A dimple/depth stop shall be formed in the branch tube to ensure that penetration into the outlet is of the correct depth. For inspection purposes, a second dimple shall be placed 6.5 mm above the first dimple. Dimples shall be aligned with the tube run.

10.3.3.8.2 **Brazed joints.** Mechanically formed tee fittings shall be brazed in accordance with Section 10.3.3.1.

10.3.4 **ABS plastic pipe.** Joints between ABS plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section 10.3.3.

10.3.5 **Brass pipe.** Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints conforming to Section 10.3.3.

10.3.6 **Brass tubing.** Joints between brass tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section 10.3.3.

10.3.7 **Copper or copper-alloy pipe.** Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, soldered, threaded or welded joints conforming to Section 10.3.3.

10.3.8 **Copper or copper-alloy tubing.** Joints between copper or copper-alloy tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section 10.3.3 or flared joints conforming to Section 10.3.8.1.

10.3.8.1 **Flared joints.** Flared joints shall be made by a tool designed for that operation.

10.3.9 **CPVC plastic pipe.** Joints between CPVC plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section 10.3.3.

10.3.10 **Polybutylene plastic pipe and tubing.** Joints between polybutylene plastic pipe and tubing or fittings shall be mechanical joints conforming to Section 10.3.3 or heat-fusion joints conforming to Section 10.3.10.1.

10.3.10.1 **Heat-fusion joints.** Joints shall be of the socket-fusion or butt-fusion type. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Joints shall be made in accordance with (ASTM D 3309).

10.3.11 **Cross-linked polyethylene (PEX) plastic tubing.** Joints between cross-linked polyethylene plastic tubing and fittings shall conform to Sections 10.3.11.1 and 10.3.11.2. Mechanical joints shall conform to Section 10.3.3.

10.3.11.1 **Compression-type fittings.** When compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

10.3.11.2 **Plastic-to-metal connections.** Soldering on the metal portion of the system shall be performed at least 460 mm from a plastic-to-metal adapter in the same water line.

10.3.12 **PVC plastic pipe.** Joints between PVC plastic pipe and fittings shall be solvent-cemented or threaded joints conforming to Section 10.3.3.

10.3.13 **Steel pipe.** Joints between steel pipe or fittings shall be mechanical joints that are made with an approved elastomeric seal, or shall be threaded or welded joints conforming to Section 10.3.3.

10.3.14 **Steel tubing.** Joints between steel tubing or fittings shall be mechanical or welded joints conforming to Section 10.3.3.

10.3.15 **Polyethylene plastic pipe and tubing for ground source heat pump loop systems.** Joints between polyethylene plastic pipe and tubing or fittings for ground source heat pump loop systems shall be heat fusion joints conforming to Section 10.3.15.1, electrofusion joints conforming to Section 10.3.15.2, or stab-type insertion joints conforming to Section 10.3.15.3.

10.3.15.1 **Heat-fusion joints.** Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, fabricated in accordance with the piping manufacturer's instructions. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with (ASTM D 2683).

10.3.15.2 **Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free of moisture, and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with (ASTM F 1055).

10.3.15.3 **Stab-type insert fittings.** Joint surfaces shall be clean and free of moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with (ASTM D 2513).

SECTION 10.4
PIPE INSULATION

10.4.1 **Insulation characteristics.** Pipe insulation installed in buildings shall conform to the requirements of the *Saudi Energy Conservation Requirements*, shall be tested in accordance with ASTM E 84 and shall have a maximum flame spread index of 25 and a smoke-developed index not exceeding 450. Insulation installed in an air plenum shall comply with Section 4.2.2.1.

Exception: The maximum flame spread index and smoke-developed index shall not apply to one- and two-family dwellings.

10.4.2 **Required thickness.** Hydronic piping shall be insulated to the thickness required by the *Saudi Building Code Energy Conservation Requirements*.

SECTION 10.5
VALVES

10.5.1 **Where required.** Shutoff valves shall be installed in hydronic piping systems in the locations indicated in Sections 10.5.1.1 through 10.5.1.6.

10.5.1.1 **Heat exchangers.** Shutoff valves shall be installed on the supply and return side of a heat exchanger.

Exception: Shutoff valves shall not be required when heat exchangers are integral with a boiler; or are a component of a manufacturer's boiler and heat exchanger packaged unit and are capable of being isolated from the hydronic system by the supply and return valves required by Section 10.5.1.

10.5.1.2 **Central systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

10.5.1.3 **Pressure vessels.** Shutoff valves shall be installed on the connection to any pressure vessel.

10.5.1.4 **Pressure-reducing valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

10.5.1.5 **Equipment and appliances.** Shutoff valves shall be installed on connections to mechanical equipment and appliances. This requirement does not apply to components of a hydronic system such as pumps, air separators, metering devices and similar equipment.

10.5.1.6 **Expansion tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

10.5.2 **Reduced pressure.** A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design. The valve shall be installed in accordance with Section 10.6.

10.5.3 **Valves supported by nonmetallic piping.** Valves and similar appurtenances shall be supported independently of nonmetallic piping systems such that the weight of these valves and appurtenances are not carried by the nonmetallic piping.

SECTION 10.6
PIPING INSTALLATION

10.6.1 **General.** Piping, valves, fittings and connections shall be installed in accordance with the conditions of approval.

10.6.1.1 **Prohibited tee applications.** Fluid in the supply side of a hydronic system shall not enter a tee fitting through the branch opening.

10.6.1.2 **Pipe Capping.** During construction and installation all pipe ends and fittings shall be plugged or capped via an approved method to avoid intrusion of contaminants.

10.6.2 **System drain down.** Hydronic piping systems shall be designed and installed to permit the system to be drained. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of the *Saudi Plumbing Requirement*s.

10.6.3 **Protection of potable water.** The potable water system shall be protected from backflow in accordance with the *Saudi Plumbing Requirements*.

10.6.4 **Pipe penetrations.** Openings for pipe penetrations in walls, floors or ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with the *Saudi Building Requirements*.

10.6.5 **Clearance to combustibles.** A pipe in a hydronic piping system in which the exterior temperature exceeds 120°C shall have a minimum clearance of 25 mm to combustible materials.

10.6.6 **Contact with building material.** A hydronic piping system shall not be in direct contact with building materials that cause the piping material to degrade or corrode, or that interfere with the operation of the system.

10.6.7 **Water hammer.** The flow velocity of the hydronic piping system shall be controlled to reduce the possibility of water hammer. Where a quick-closing valve creates water hammer, an approved water-hammer arrestor shall be installed. The arrestor shall be located within a range as specified by the manufacturer of the quick-closing valve.

10.6.8 **Steam piping pitch.** Steam piping shall be installed to drain to the boiler or the steam trap. Steam systems shall not have drip pockets that reduce the capacity of the steam piping.

10.6.9 **Strains and stresses.** Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

10.6.9.1 **Flood hazard.** Piping located in a flood-hazard zone or high-hazard zone shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

10.6.10 **Pipe support.** Pipe shall be supported in accordance with Section 1.5.

10.6.11 **Condensation.** Provisions shall be made to prevent the formation of condensation on the exterior of piping.

10.6.12 **Vibration Isolation.** All piping, fittings and appurtenances shall be protected from vibration via materials as per 10.1.10 and 10.2.7.

SECTION 10.7
TRANSFER FLUID

10.7.1 **Flash point.** The flash point of transfer fluid in a hydronic piping system shall be a minimum of 28°C above the maximum system operating temperature.

10.7.2 **Makeup water.** The transfer fluid shall be compatible with the makeup water supplied to the system.

SECTION 10.8
TESTS

10.8.1 **General.** Hydronic piping systems other than ground-source heat pump loop systems shall be tested hydrostatically at one and one half times the maximum system design pressure, but not less than 690 kPa. The duration of each test shall be 24 hours +/- ½ hour with no observed leaks. Ground-source heat pump loop systems shall be tested in accordance with Section 10.8.1.1.

10.8.1.1 Ground source heat pump loop systems. Before header connection trenches are backfilled and prior to insertion of u-bend pipe loops into the earth, the assembled loop system shall be pressure tested with water at a minimum pressure of 690 kPa for a duration of 24 hours +/- ½ hour with no observed leaks. Flow and pressure loss testing shall be performed and the actual flow rates and pressure drops shall be compared to the calculated design values. If actual flow rate or pressure drop values differ from calculated design values by more than 10 percent, the problem shall be identified and corrected prior to backfilling trenches or insertion of u-bend pipe loops into the earth.

10.8.2 Chilled water and cooling water hydrostatic testing pressure. Hydro-testing of chilled water and cooling water piping shall be at a minimum test pressure of 1.5 times the design pressure.

10.8.3 Hydro-testing pressure drop. In case of pressure drop at the conclusion of the hydro-testing by 10% or more than from the calculated design values then all leaks shall be identified and corrected prior to operating the system.

SECTION 10.9
EMBEDDED PIPING

10.9.1 Materials. Piping for heating panels shall be standard-weight steel pipe, Type L copper tubing, polybutylene or other approved plastic pipe or tubing rated at 690 kPa at 82^{o}C.

10.9.2 Pressurizing during installation. Piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

10.9.3 Embedded joints. Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster, shall be in accordance with the requirements of Sections 10.9.3.1 through 10.9.3.3.

10.9.3.1 Steel pipe joints. Steel pipe shall be welded by electrical arc or oxygen/acetylene method.

10.9.3.2 Copper tubing joints. Copper tubing shall be joined by brazing with filler metals having a melting point of not less than 538^{o}C.

10.9.3.3 Polybutylene joints. Polybutylene pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion in accordance with Section 10.3.10.1.

10.9.4 Not embedded related piping. Joints of other piping in cavities or running exposed shall be joined by approved methods in accordance with manufacturer's installation instructions and related sections of these requirements.

CHAPTER 11
FUEL OIL PIPING AND STORAGE

SECTION 11.1
GENERAL

11.1.1 **Scope.** This chapter shall govern the design, installation, construction and repair of fuel-oil storage and piping systems. The storage of fuel oil and flammable and combustible liquids shall be in accordance with the *Saudi Fire Requirements*.

11.1.2 **Storage and piping systems.** Fuel-oil storage systems shall comply with the *Saudi Fire Requirements*. Fuel-oil piping systems shall comply with the requirements of these requirements.

11.1.3 **Fuel type.** An appliance shall be designed for use with the type of fuel to which it will be connected. Such appliance shall not be converted from the fuel specified on the rating plate for use with a different fuel without securing approval from the code official.

11.1.4 **Fuel tanks, piping and valves.** The tank, piping and valves for appliances burning oil shall be installed in accordance with the requirements of this chapter. When an oil burner is served by a tank, any part of which is above the level of the burner inlet connection and where the fuel supply line is taken from the top of the tank, an approved siphon-breaking device shall be installed in lieu of the shutoff valve.

SECTION 11.2
MATERIAL

11.2.1 **General.** Piping materials shall conform to the standards cited in this section.

11.2.2 **Rated for system.** All materials shall be rated for the operating temperatures and pressures of the system, and shall be compatible with the type of liquid.

11.2.3 **Pipe standards.** Fuel oil pipe shall comply with one of the standards listed in Table 11.2.3.

Table 11.2.3
Fuel Oil Piping

Material	Standard
Brass pipe	(ASTM B 43)
Brass tubing	(ASTM B 135)
Copper or copper-alloy pipe	(ASTM B 42; ASTM B 302)
Copper or copper-alloy tubing (Type K, L or M)	(ASTM B 75; ASTM B 88; ASTM B 280)
Labeled pipe	(See section 1102.4)
Nonmetallic pipe	(ASTM D 2996)
Steel pipe	(ASTM A 53; ASTM A 106)
Steel tubing	(ASTM A 254; ASTM A 539)

11.2.4 **Nonmetallic pipe.** All nonmetallic pipes shall be listed and labeled as being acceptable for the intended application for flammable and combustible liquids. Nonmetallic pipe shall be installed only outside, underground.

11.2.5 **Fittings and valves.** Fittings and valves shall be approved for the piping systems, and shall be compatible with, or shall be of the same material as, the pipe or tubing.

11.2.6 **Bending of pipe.** Pipe shall be approved for bending. Pipe bends shall be made with approved equipment. The bend shall not exceed the structural limitations of the pipe.

11.2.7 **Pumps.** Pumps that are not part of an appliance shall be of a positive-displacement type. The pump shall automatically shut off the supply when not in operation. Pumps shall be listed and labeled in accordance with (UL 343).

11.2.8 **Flexible connectors and hoses.** Flexible connectors and hoses shall be listed and labeled in accordance with (UL 536).

SECTION 11.3
JOINTS AND CONNECTIONS

11.3.1 **Approval.** Joints and connections shall be approved and of a type approved for fuel-oil piping systems. All threaded joints and connections shall be made tight with suitable lubricant or pipe compound. Unions requiring gaskets or packing, right or left couplings, and sweat fittings employing solder having a melting point of less than 540^{o}C shall not be used in oil lines. Cast-iron fittings shall not be used. Joints and connections shall be tight for the pressure required by test.

11.3.1.1 **Joints between different piping materials.** Joints between different piping materials shall be made with approved adapter fittings. Joints between different metallic piping materials shall be made with approved dielectric fittings or brass converter fittings.

11.3.2 **Preparation of pipe ends.** All pipe shall be cut square, reamed and chamfered and be free of all burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

11.3.3 **Joint preparation and installation.** Where required by Sections 11.3.4 through 11.3.10, the preparation and installation of brazed, mechanical, threaded and welded joints shall comply with Sections 11.3.3.1 through 11.3.3.4.

11.3.3.1 **Brazed joints.** All joint surfaces shall be cleaned. An approved flux shall be applied where required. The joints shall be brazed with a filler metal conforming to (AWS A5.8).

1103.3.2 **Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

11.3.3.3 **Threaded joints.** Threads shall conform to (ASME B1.20.1). Pipe-joint compound or tape shall be applied on the male threads only.

11.3.3.4 **Welded joints.** All joint surfaces shall be cleaned by approved procedure. The joint shall be welded with an approved filler metal.

11.3.4 **Brass pipe.** Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints complying with Section 11.3.3.

11.3.5 **Brass tubing.** Joints between brass tubing or fittings shall be brazed or mechanical joints complying with Section 11.3.3.

11.3.6 **Copper or copper-alloy pipe.** Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, threaded or welded joints complying with Section 11.3.3.

11.3.7 **Copper or copper-alloy tubing.** Joints between copper or copper-alloy tubing or fittings shall be brazed or mechanical joints complying with Section 11.3.3 or flared joints. Flared joints shall be made by a tool designed for that operation.

11.3.8 **Nonmetallic pipe.** Joints between nonmetallic pipe or fittings shall be installed in accordance with the manufacturer's instructions for the labeled pipe and fittings.

11.3.9 **Steel pipe.** Joints between steel pipe or fittings shall be threaded or welded joints complying with Section 11.3.3 or mechanical joints complying with Section 11.3.9.1.

11.3.9.1 **Mechanical joints.** Joints shall be made with an approved elastomeric seal. Mechanical joints shall be installed in accordance with the manufacturer's instructions. Mechanical joints shall be installed outside, underground, unless otherwise approved.

11.3.10 **Steel tubing.** Joints between steel tubing or fittings shall be mechanical or welded joints complying with Section 11.3.3.

11.3.11 **Piping protection.** Proper allowance shall be made for expansion, contraction, jarring and vibration. Piping other than tubing, connected to underground tanks, except straight fill lines and test wells, shall be provided with flexible connectors, or otherwise arranged to permit the tanks to settle without impairing the tightness of the piping connections.

SECTION 11.4
PIPING SUPPORT

11.4.1 **General.** Pipe supports shall be in accordance with Section 1.5.

SECTION 11.5
FUEL OIL SYSTEM INSTALLATION

11.5.1 **Size.** The fuel oil system shall be sized for the maximum capacity of fuel oil required. The minimum size of a supply line shall be 10 mm inside diameter nominal pipe or 10 mm OD tubing. The minimum size of a return line shall be 7 mm inside diameter nominal pipe or 8 mm outside diameter tubing. Copper tubing shall have 0.9 mm nominal and 0.8 mm minimum wall thickness.

11.5.2 **Protection of pipe, equipment and appliances.** All fuel oil pipe, equipment and appliances shall be protected from physical damage.

11.5.2.1 **Flood hazard.** All fuel oil pipe, equipment and appliances located in flood hazard areas shall be located above the design flood elevation or shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

11.5.3 **Supply piping.** Supply piping shall connect to the top of the fuel oil tank. Fuel oil shall be supplied by a transfer pump or automatic pump or by other approved means.
Exception: This section shall not apply to inside or above-ground fuel oil tanks.

11.5.4 **Return piping.** Return piping shall connect to the top of the fuel oil tank. Valves shall not be installed on return piping.

11.5.5 **System pressure.** The system shall be designed for the maximum pressure required by the fuel-oil-burning appliance. Air or other gases shall not be used to pressurize tanks.

11.5.6 **Fill piping.** A fill pipe shall terminate outside of a building at a point at least 60 cm from any building opening at the same or lower level. A fill pipe shall terminate in a manner designed to minimize spilling when the filling hose is disconnected. Fill opening shall be equipped with a tight metal cover designed to discourage tampering.

11.5.7 **Vent piping.** Liquid fuel vent pipes shall terminate outside of buildings at a point not less than 60 cm measured vertically or horizontally from any building opening. Outer ends of vent pipes shall terminate in a weatherproof vent cap or fitting or be provided with a weatherproof hood. All vent caps shall have a minimum free open area equal to the cross-sectional area of the vent pipe and shall not employ screens finer than No. 4 mesh. Vent pipes shall terminate sufficiently above the ground to avoid being obstructed with sand, snow or ice. Vent pipes from tanks containing heaters shall be extended to a location where oil vapors discharging from the vent will be readily diffused. If the static head with a vent pipe filled with oil exceeds 70 kPa, the tank shall be designed for the maximum static head that will be imposed. Liquid fuel vent pipes shall not be cross connected with fill pipes, lines from burners or overflow lines from auxiliary tanks.

SECTION 11.6
OIL GAUGING

11.6.1 **Level indication.** All tanks in which a constant oil level is not maintained by an automatic pump shall be equipped with a method of determining the oil level.

11.6.2 **Test wells.** Test wells shall not be installed inside buildings. For outside service, test wells shall be equipped with a tight metal cover designed to discourage tampering.

11.6.3 **Inside tanks.** The gauging of inside tanks by means of measuring sticks shall not be permitted. An inside tank provided with fill and vent pipes shall be provided with a device to indicate either visually or audibly at the fill point when the oil in the tank has reached a predetermined safe level.

11.6.4 **Gauging devices.** Gauging devices such as liquid level indicators or signals shall be designed and installed so that oil vapor will not be discharged into a building from the liquid fuel supply system.

11.6.5 **Gauge glass.** A tank used in connection with any oil burner shall not be equipped with a glass gauge or any gauge which, when broken, will permit the escape of oil from the tank.

SECTION 11.7
FUEL OIL VALVES

11.7.1 **Building shutoff.** A shutoff valve shall be installed on the fuel-oil supply line at the entrance to the building. Inside or above-ground tanks are permitted to have valves installed at the tank. The valve shall be capable of stopping the flow of fuel oil to the building or to the appliance served where the valve is installed at a tank inside the building.

11.7.2 **Appliance shutoff.** A shutoff valve shall be installed at the connection to each appliance where more than one fuel-oil-burning appliance is installed.

11.7.3 **Pump relief valve.** A relief valve shall be installed on the pump discharge line where a valve is located downstream of the pump and the pump is capable of exceeding the pressure limitations of the fuel oil system.

11.7.4 **Fuel-oil heater relief valve.** A relief valve shall be installed on the discharge line of fuel-oil-heating appliances.

11.7.5 **Relief valve operation.** The relief valve shall discharge fuel oil when the pressure exceeds the limitations of the system. The discharge line shall connect to the fuel oil tank.

SECTION 11.8
TESTING

11.8.1 **Testing required.** Fuel oil piping shall be tested in accordance with (NFPA 31).

CHAPTER 12
SOLAR SYSTEMS

SECTION 12.1
GENERAL

12.1.1 **Scope.** This chapter shall govern the design, construction, installation, alteration and repair of systems, equipment and appliances intended to utilize solar energy for space heating or cooling, domestic hot water heating, swimming pool heating or process heating.

12.1.2 **Potable water supply.** Potable water supplies to solar systems shall be protected against contamination in accordance with the *Saudi Building Code Sanitary Requirements*.
Exception: Where all solar system piping is a part of the potable water distribution system, in accordance with the requirements of the *Saudi Building Code Sanitary Requirements*, and all components of the piping system are listed for potable water use, cross-connection protection measures shall not be required.

12.1.3 **Heat exchangers.** Heat exchangers used in domestic water-heating systems shall be approved for the intended use. The system shall have adequate protection to ensure that the potability of the water supply and distribution system is properly safeguarded.

12.1.4 **Solar energy equipment and appliances.** Solar energy equipment and appliances shall conform to the requirements of this chapter and shall be installed in accordance with the manufacturer's installation instructions.

12.1.5 **Ducts.** Ducts utilized in solar heating and cooling systems shall be constructed and installed in accordance with Chapter 4 of these Requirements.

SECTION 12.2
INSTALLATION

12.2.1 **Access.** Access shall be provided to solar energy equipment and appliances for maintenance. Solar systems and appurtenances shall not obstruct or interfere with the operation of any doors, windows or other building components requiring operation or access.

12.2.2 **Protection of equipment.** Solar equipment exposed to vehicular traffic shall be installed not less than 1.8 m above the finished floor.
Exception: This section shall not apply where the equipment is protected from motor vehicle impact.

12.2.3 **Controlling condensation.** Where attics or structural spaces are part of a passive solar system, ventilation of such spaces, as required by Section 2.6, is not required where other approved means of controlling condensation are provided.

12.2.4 **Roof-mounted collectors.** Roof-mounted solar collectors that also serve as a roof covering shall conform to the requirements for roof coverings in accordance with the *Saudi Building Code*.

Exception: The use of plastic solar collector covers shall be limited to those approved plastics meeting the requirements for plastic roof panels in the *Saudi Building Code*.

12.2.4.1 **Collectors mounted above the roof.** When mounted on or above the roof covering, the collector array and supporting construction shall be constructed of noncombustible materials or fire-retardant-treated wood conforming to the *Saudi Building Code* to the extent required for the type of roof construction of the building to which the collectors are accessory.

Exception: The use of plastic solar collector covers shall be limited to those approved plastics meeting the requirements for plastic roof panels in the *Saudi Building Code*.

12.2.5 **Equipment.** The solar energy system shall be equipped in accordance with the requirements of Sections 12.2.5.1 through 12.2.5.4.

12.2.5.1 **Pressure and temperature.** Solar energy system components containing pressurized fluids shall be protected against pressures and temperatures exceeding design limitations with a pressure and temperature relief valve. Each section of the system in which excessive pressures are capable of developing shall have a relief device located so that a section cannot be valved off or otherwise isolated from a relief device. Relief valves shall comply with the requirements of Section 8.6.4 and discharge in accordance with Section 8.6.6.

12.2.5.2 **Vacuum.** The solar energy system components that are subjected to a vacuum while in operation or during shutdown shall be designed to withstand such vacuum or shall be protected with vacuum relief valves.

12.2.5.3 **Protection from freezing.** System components shall be protected from damage by freezing of heat transfer liquids at the lowest ambient temperatures that will be encountered during the operation of the system.

12.2.5.4 **Expansion tanks.** Liquid single-phase solar energy systems shall be equipped with expansion tanks sized in accordance with Section 8.9.

12.2.6 **Penetrations.** Roof and wall penetrations shall be flashed and sealed to prevent entry of water, rodents and insects.

12.2.7 **Filtering.** Air transported to occupied spaces through rock or dust-producing materials by means other than natural convection shall be filtered at the outlet from the heat storage system.

SECTION 12.3
HEAT TRANSFER FLUIDS

12.3.1 **Flash point.** The flash point of the actual heat transfer fluid utilized in a solar system shall be not less than 28ºC above the design maximum non-operating (no-flow) temperature of the fluid attained in the collector.

12.3.2 **Flammable gases and liquids.** A flammable liquid or gas shall not be utilized as a heat transfer fluid.

CHAPTER 13
ELEVATORS AND CONVEYING SYSTEMS

SECTION 13.1
GENERAL

13.1.1 **Scope.** This chapter governs the design, construction, installation, alteration and repair of elevators and conveying systems and their components.

13.1.2 **Referenced Standards.** Except as otherwise provided for in these requirements, the design, construction, installation, alteration, repair and maintenance of elevators and conveying systems and their components shall conform to (ASME A17.1), (ASME A90.1), (ASME B20.1), (ALI ALCTV), and (ASCE 24) for construction in flood hazard areas established in SBC (Section 16.12.3).

13.1.3 **Accessibility.** Passenger elevators required to be accessible shall conform to (ICC A117.1).

13.1.4 **Change in use.** A change in use of an elevator from freight to passenger, passenger to freight, or from one freight class to another freight class shall comply with Part XII of (ASME A17.1).

SECTION 13.2
HOISTWAY ENCLOSURES

13.2.1 **Hoistway enclosure protection.** Elevator, dumbwaiter and other hoistway enclosures shall have a fire-resistance rating not less than that specified and constructed in accordance with Saudi Building Code.

13.2.1.1 **Opening protective.** Openings in hoistway enclosures shall be protected as required in Saudi Building Code.

13.2.1.2 **Hardware.** Hardware on opening protective shall be of an approved type installed as tested, except that approved interlocks, mechanical locks and electric contacts, door and gate electric contacts and door-operating mechanisms shall be exempt from the fire test requirements.

13.2.2 **Number of elevator cars in a hoistway.** Where four or more elevator cars serve all or the same portion of a building, the elevators shall be located in at least two separate hoistways. Not more than four elevator cars shall be located in any single hoistway enclosure.

13.2.3 **Emergency signs.** An approved pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit stairways and not to use the elevators in case of fire. The sign shall read:

IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS.

The emergency sign shall not be required for elevators that are part of an accessible means of egress.

13.2.4 **Elevator car to accommodate ambulance stretcher.** In buildings four stories in height or more, at least one elevator shall be provided for fire department emergency access to all floors. Such elevator car shall be of such a size and arrangement to accommodate a 600 mm by 1900 mm ambulance stretcher in the horizontal, open position and shall be identified by the international symbol for

emergency medical services (star of life). The symbol shall not be less than 75 mm high and shall be placed inside on both sides of the hoistway door frame.

13.2.5 **Emergency doors.** Where an elevator is installed in a single blind hoistway or on the outside of a building, there shall be installed in the blind portion of the hoistway or blank face of the building, an emergency door in accordance with (ASME A17.1).

13.2.6 **Prohibited doors.** Doors, other than hoistway doors and the elevator car door, shall be prohibited at the point of access to an elevator car unless such doors are readily openable from the car side without a key, tool, special knowledge or effort.

13.2.7 **Common enclosure with stairway.** Elevators shall not be in a common shaft enclosure with a stairway.

SECTION 13.3
EMERGENCY OPERATIONS

13.3.1 **Standby power.** In buildings and structures where standby power is required or furnished to operate an elevator, the operation shall be in accordance with Sections 13.3.1.1 through 13.3.1.4.

13.3.1.1 **Manual transfer.** Standby power shall be manually transferable to all elevators in each bank.

13.3.1.2 **One elevator.** Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

13.3.1.3 **Two or more elevators.** Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, at least one elevator shall remain operable from the standby power source.

13.3.1.4 **Venting.** Where standby power is connected to elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

13.3.2 **Fire-fighters' emergency operation.** Elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with (ASME A17.1).

SECTION 13.4
HOISTWAY VENTING

13.4.1 **Vents required.** Hoistways of elevators and dumbwaiters penetrating more than three stories shall be provided with a means for venting smoke and hot gases to the outer air in case of fire.

Exceptions:

1. In occupancies of other than Groups R-1, R-2, I-1, I-2 and similar occupancies with overnight sleeping quarters, venting of hoistways is not required where the building is equipped throughout with an approved automatic sprinkler system installed in accordance with Saudi Building Code.

2. Sidewalk elevator hoistways are not required to be vented.

13.4.2 **Location of vents.** Vents shall be located below the floor or floors at the top of the hoistway, and shall open either directly to the outer air or through noncombustible ducts to the outer air. Noncombustible ducts shall be permitted to pass through the elevator machine room provided that portions of the ducts located outside the hoistway or machine room are enclosed by construction having not less than the fire protection rating required for the hoistway. Holes in the machine room floors for the passage of ropes, cables or other moving elevator equipment shall be limited so as not to provide greater than 50 mm of clearance on all sides.

13.4.3 **Area of vents.** Except as provided for in Section 13.4.3.1, the area of the vents shall not be less than 3.5% of the area of the hoistway nor less than 0.27 m^2 for each elevator car, and not less than 3.5% nor less than 0.045 m^2 for each dumbwaiter car in the hoistway, whichever is greater. Of the total required vent area, not less than one-third shall be of the permanently open type unless all vents activate upon detection of smoke from any of the elevator lobby smoke detectors.

13.4.3.1 **Reduced vent area.** Where mechanical ventilation conforming to the Saudi Mechanical Requirements is provided, a reduction in the required vent area is allowed provided that all of the following conditions are met:

1. The occupancy is not in Group R-1, R-2, I-1 or I-2 or of a similar occupancy with overnight sleeping quarters.
2. The vents required by Section 13.4.2 do not have outside exposure.
3. The hoistway does not extend to the top of the building.
4. The hoistway and machine room exhaust fan is automatically reactivated by thermostatic means.
5. Equivalent venting of the hoistway is accomplished.

13.4.4 **Closed vents.** Closed portions of the required vent area shall consist of windows or duct openings glazed with annealed glass not more than 3 mm thick.

13.4.5 **Plumbing and mechanical systems.** Plumbing and mechanical systems shall not be located in an elevator shaft.

Exception: Floor drains, sumps and sump pumps shall be permitted at the base of the shaft provided they are indirectly connected to the plumbing system.

SECTION 13.5
CONVEYING SYSTEMS

13.5.1 **General.** Escalators, moving walks, conveyors, personnel hoists and material hoists shall comply with the provisions of this section.

13.5.2 **Escalators and moving walks.** Escalators and moving walks shall be constructed of approved noncombustible and fire-retardant materials. These requirements shall not apply to electrical equipment, wiring, wheels, handrails and the use of 0.9 mm wood veneers on balustrades backed up with noncombustible materials.

13.5.2.1 **Enclosure.** Escalator floor openings shall be enclosed except where allowed by Saudi Building Code.

13.5.2.2 **Escalators.** Where provided in below-grade transportation stations, escalators shall have a clear width of 800 mm minimum.

Exception: The clear width is not required in existing facilities undergoing alterations.

13.5.3 **Conveyors.** Conveyors and conveying systems shall comply with (ASME B20.1).

13.5.3.1 **Enclosure.** Conveyors and related equipment connecting successive floors or levels shall be enclosed with fire barrier walls and approved opening protectives complying with the requirements of Saudi Building Code.

13.5.3.2 **Conveyor safeties.** Power-operated conveyors, belts and other material-moving devices shall be equipped with automatic limit switches which will shut off the power in an emergency and automatically stop all operation of the device.

13.5.4 **Personnel and material hoists.** Personnel and material hoists shall be designed utilizing an approved method that accounts for the conditions imposed during the intended operation of the hoist device. The design shall include, but is not limited to, anticipated loads, structural stability, impact, vibration, stresses and seismic restraint. The design shall account for the construction, installation, operation and inspection of the hoist tower, car, machinery and control equipment, guide members and hoisting mechanism. Additionally, the design of personnel hoists shall include provisions for field testing and maintenance which will demonstrate that the hoist device functions in accordance with the design. Field tests shall be conducted upon the completion of an installation or following a major alteration of a personnel hoist.

SECTION 13.6
MACHINE ROOMS

13.6.1 **Access.** An approved means of access shall be provided to elevator machine rooms and overhead machinery spaces.

13.6.2 **Venting.** Elevator machine rooms that contain solid-state equipment for elevator operation shall be provided with an independent ventilation or air-conditioning system to protect against the overheating of the electrical equipment. The system shall be capable of maintaining temperatures within the range established for the elevator equipment.

13.6.3 **Pressurization.** The elevator machine room serving a pressurized elevator hoistway shall be pressurized upon activation of a heat or smoke detector located in the elevator machine room.

13.6.4 **Machine rooms and machinery spaces.** Elevator machine rooms and machinery spaces shall be enclosed with construction having a fire-resistance rating not less than the required rating of the hoistway enclosure served by the machinery. Openings shall be protected with assemblies having a fire-resistance rating not less than that required for the hoistway enclosure doors.

13.6.5 **Shunt trip.** Where elevator hoistways or elevator machine rooms containing elevator control equipment are protected with automatic sprinklers, a means installed in accordance with (NFPA 72, Section 3-8.15), Elevator Shutdown, shall be provided to disconnect automatically the main line power supply to the affected elevator prior to the application of water. This means shall not be self-resetting. The activation of sprinklers outside the hoistway or machine room shall not disconnect the main line power supply.

13.6.6 **Plumbing systems.** Plumbing systems shall not be located in elevator equipment rooms.

SECTION 13.7
SPECIAL PROVISIONS FOR DISABLED PEOPLE IN ELEVATORS

13.7.1 **Elevators in multi-story buildings.** Elevators in multi-story buildings shall satisfy the following requirements:

13.7.1.1 **Hydraulic elevators.** Hydraulic elevators shall be used in order to ensure that landing occurs at exactly the required level.

13.7.1.2 **Public buildings.** Public buildings and buildings intended for disabled people shall be provided with elevators having dimensions in accordance with the specifications set by the legislative authority.

13.7.1.3 **Elevator foyer.** Sufficient area (at least 1.5 m x 1.5 m) shall be provided at entrance to the elevator in order to provide disabled people on wheelchairs with freedom of movement and maneuvering to access the elevator. In ground floor and places with heavy passenger traffic the depth shall be at least 1.8 m.

13.7.1.4 **Elevator cars.** Elevator cars shall satisfy the following requirements:

- Side and back walls of the elevator car shall be provided with handrails. Handrails shall be located 1.0 m above the car floor level and no more than 40 mm from car walls. They shall be strong enough and well secured. Rectangular (75 mm x 75 mm) or circular (30 mm diameter) handrails may be used.
- Elevator cars interior walls shall be of a type resistant to impact by wheelchairs.
- Elevator cars shall have a minimum depth of 1.4m and a minimum width of 1.1 m. Exception: cars intended for use by severely disabled people on larger-size wheelchairs, in which case the minimum dimensions shall be 1.8 m x 1.8 m.

13.7.1.5 **Elevator doors.** Elevator doors shall satisfy the following requirements:

- The net width of the elevator door shall be at least 0.8 m, preferably 1.0 m.
- Provision shall be made to allow manual opening of the door in case of electric power failure. Side-hung doors shall be preferred to sliding doors.
- Door closing speed shall not exceed 0.3 m/s in residential buildings and buildings intended to be used by disabled people. In other buildings, this speed shall not exceed 0.5 m/s.
- Photoelectric cells shall be used to control opening and closing of elevator doors.
- In cases where no photoelectric cells are provided, devices that help keep the door open for at least 6 sec. shall be installed on the doors, in order to protect disabled people.

13.7.1.6 **Control buttons and signs in elevators.** Control buttons and signs shall satisfy the following requirements:

- Control buttons shall be of an easy-to-use type and located in a visible readily accessible location. Illuminating touch-on buttons shall be preferable to push buttons. Touch-on buttons shall have a minimum diameter of 30 mm, while push buttons shall have a minimum diameter of 15 mm.
- Cars shall be provided with emergency devices such as simple, readily accessible alarms and phones. These shall be provided with a special backup battery capable of operating in case of electric power failure.
- Control devices in elevators installed in residential buildings and in buildings intended for use by users of canes shall have a maximum elevation of 1.6 m with a mean elevation of 1.4 m. For wheelchair users the elevation of the topmost device shall not exceed 1.3 m while the mean elevation of these devices shall be approximately 1.0 m.
- Control devices arranged horizontally on the car wall in heavily used buildings or buildings intended for use by disabled people shall be at an elevation not

exceeding 1.0 m, provided that distance of control panel from car door is at least 0.6 m.

- Control devices shall be disposed on the sidewalls instead of the wall of the car door.
- The elevator shall be provided with comprehensive signs/signals displaying its motion and speed so that disabled people may easily get acquainted with the elevator and prepare themselves to get into it. Examples of such signs/signals may be: "Elevator is coming" and or the number of the level the elevator passes at the moment.
- Additional audible signals shall be provided to indicate arrival of the elevator for cases where blind people use the elevator. Such audible signals may be different according to the elevator ascending or descending.
- Signs shall be installed at elevator parking, showing the parking level.
- Signals that can be seen from all locations within the car shall be provided inside the elevator car indicating the current level and the direction of motion.
- In buildings such as hotels, offices and supermarkets, elevator cars may be provided with information panels about various services, shops and activities in each level.

13.7.2 **Elevators in private homes.** Various types of elevators may be used in private homes and villas accommodating one or more disabled people or elderly members.

13.7.3 **Conveyor belts.** Conveyor belts shall satisfy the following requirements:

- Conveyor belts are shall be preferred to escalators in transporting wheelchair users. To enable these disabled people to be transported, conveyor belts shall have a width of at least 0.8 m, preferably 1.0 m.
- Inclination of conveyor belts shall not exceed 20%.

13.7.4 **Escalators.** If escalators are used, elevators shall be additionally installed.

13.7.5 **Stair elevators.** Various types of stair elevators may be used. These elevators shall be installed on the side barriers protecting the staircase. In such case, these barriers shall be strongly secured.

CHAPTER 14
MECHANICAL MAINTENANCE REQUIREMENTS

SECTION 14.1
GENERAL

14.1.1 **Scope.** The provisions of this chapter shall govern the minimum mechanical facilities and equipment to be provided.

14.1.2 **Responsibility.** The owner of the structure shall provide and maintain mechanical facilities and equipment in compliance with these requirements. A person shall not occupy as owner-occupant or permit another person to occupy any premises which does not comply with the requirements of this chapter.

SECTION 14.2
COOLING AND HEATING FACILITIES

14.2.1 **Facilities required.** Cooling and heating facilities shall be provided in structures as required by this section.

14.2.2 **Residential occupancies.** Dwellings shall be provided with cooling and heating facilities capable of maintaining a room temperature of 20^{o}C in all habitable rooms, bathrooms and toilet rooms based on the summer/winter outdoor design temperature.

SECTION 14.3
MECHANICAL EQUIPMENT

14.3.1 **Mechanical appliances.** All mechanical appliances, air conditioning, fireplaces, solid fuel-burning appliances, cooking appliances and water heating appliances shall be properly installed and maintained in a safe working condition, and shall be capable of performing the intended function.

14.3.2 **Removal of combustion products.** All fuel-burning equipment and appliances shall be connected to an approved chimney or vent.
Exception: Fuel-burning equipment and appliances which are labeled for unvented operation.

14.3.3 **Clearances.** All required clearances to combustible materials shall be maintained.

14.3.4 **Safety controls.** All safety controls for fuel-burning equipment shall be maintained in effective operation.

14.3.5 **Combustion air.** A supply of air for complete combustion of the fuel and for ventilation of the space containing the fuel-burning equipment shall be provided for the fuel-burning equipment.

14.3.6 **Energy conservation devices.** Devices intended to reduce fuel consumption by attachment to a fuel-burning appliance, to the fuel supply line thereto, or to the vent outlet or vent piping there from, shall not be installed unless labeled for such purpose and the installation is specifically approved.

SECTION 14.4
ELEVATORS AND ESCALATORS

14.4.1 **General.** Elevators and escalators shall be maintained to sustain safely all imposed loads, to operate properly, and to be free from physical and fire hazards. The most current certificate of inspection shall be on display at all times within the elevator or attached to the escalator or the certificate shall be available for public inspection in the office of the building operator.

14.4.2 **Elevators.** In buildings equipped with passenger elevators, at least one elevator shall be maintained in operation at all times when the building is occupied.
Exception: Buildings equipped with only one elevator shall be permitted to have the elevator temporarily out of service for testing or servicing.

SECTION 14.5
DUCT SYSTEMS

14.5.1 **General.** Duct systems shall be maintained free of obstructions and shall be capable of performing the required function.

REFERENCED STANDARDS

These are the standards referenced within SBC 501. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title. The application of the referenced standards shall be as specified in SBC.

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3. ANSI, Z21.83—1998, Fuel Cell Power Plants, American National Standards Institute, 11 West 42nd Street, New York, NY 10036.
4. ARI, 700—95, Specifications for Fluorocarbon and Other Refrigerants, Air-Conditioning and Refrigeration Institute, Suite 425, 4301 North Fairfax Drive, Arlington, VA 22203.
5. ASHRAE, ASHRAE—2001, ASHRAE Fundamentals Handbook—2001, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.
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